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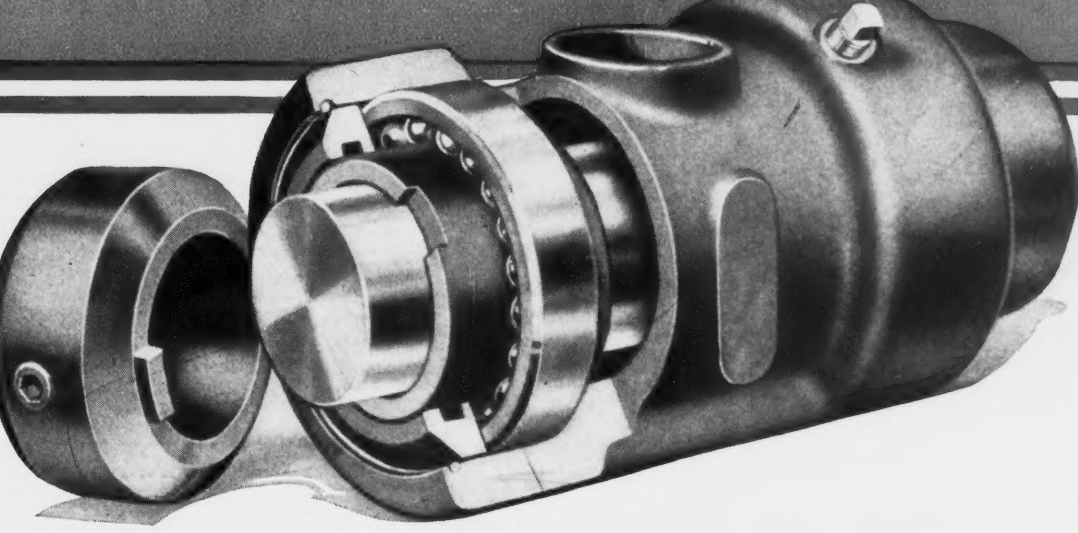

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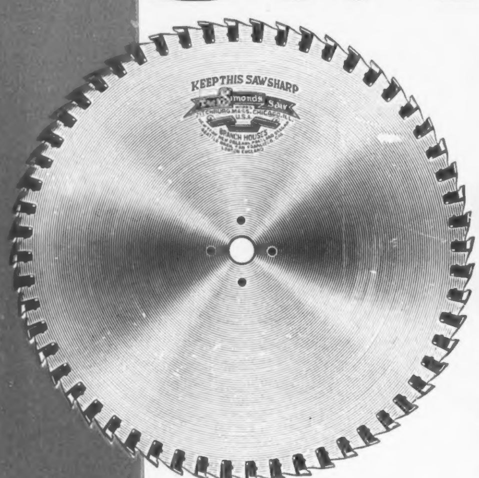

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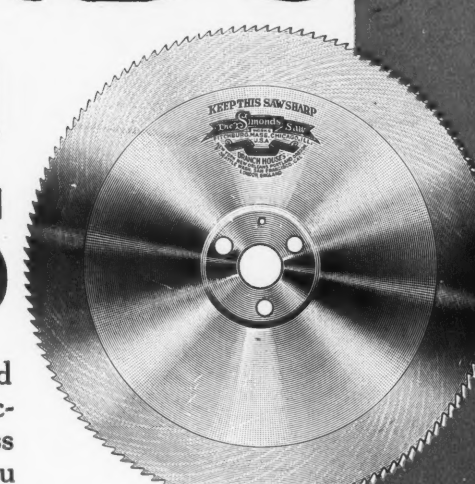

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Hobbing Spiral Bevel Gears

A New Development in Gear-cutting Practice that Makes it Possible to Produce Accurate Spiral Bevel Gears by a Hobbing Process

By NIKOLA TRBOJEVICH, Mechanical Engineer, National Twist Drill & Tool Co., Detroit, Mich.

MANY attempts have been made in the past to evolve a process for hobbing bevel gears, as it is generally conceded that hobbing is one of the most efficient methods of manufacturing gearing. These attempts have all proved unsuccessful as applied to straight-tooth bevel gears, but it is now possible, as the result of the discovery of the new tooth spirals referred to later, not only to cut spiral bevel gears at a comparatively rapid rate by a special application of the hobbing principle, but also to produce gear teeth that conform within exceedingly close limits to the theoretically correct shape. This remarkable process was developed by the National Twist Drill & Tool Co., of Detroit, Mich., and U. S. patents covering it have recently been issued. These hobbed spiral bevel gears are similar in outward appearance to the spiral bevel gears generally used in rear axle drives of automobiles. However, they differ from the conventional gears in the following points:

1. They have a "parallel depth" of tooth.

2. They mesh crosswise with a rack element of constant pitch.

3. Their normal tooth thickness is very nearly the same at all points.

4. The helix angle is less at the small end of the gear than at the large end, the usual helix angle being 27 degrees at the small end and 45 at the large end, averaging 36 degrees.

5. They are capable of meshing in a dual fashion, similar to ordinary spur helical gears, that is, with a rolling engagement when one is right-hand and the other left-hand and the corresponding pitch cone radii and the helix angles are the same, and with a sliding engagement when the helix angles are different. In the latter case the axis of the pinion does not lie in the same plane with the axis of the gear.

6. They are capable of meshing with a tapered screw of constant pitch.

7. When correctly cut, they have a contact all over (from one end of the tooth to the other) similar to the common spur or helical gears. This condition is due to the fact that the pitch helixes on the convex and the concave sides of the teeth are exactly alike and have the same radii of curvature at all corresponding points.

In developing a method of hobbing spiral bevel gearing, the process should be such that the tooth curves are both longitudinally and transversely correct at every point so that they satisfy the kinematical requirements that directly follow from the well-known Sang and Bilgram principles. The writer hopes to show clearly in the following description of this new process, first, that it is a true hobbing process in the full sense of the word, and therefore highly productive, and second, that the gears produced by this method are

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Spiral type bevel gears may be hobbed by the process described in this article about as readily as common spur and helical gears are hobbed. The process is continuous, and both sides of the teeth are finished during the same cut, whether a gear or a pinion is being hobbed. The cutting time, both for roughing and finishing, is about the same as for spur gears of similar size. The cutting tool is a tapered hob of constant lead. This hob is usually single-threaded and has straight gashes. The same process may also be employed for hobbing hyperboloidal gears having spiral teeth. The hyperboloidal worm drive is a new combination in the art of gearing. The author believes that this worm drive, which in some respects is superior to any other known worm drive, will be used extensively in the future in mechanisms requiring a compact drive of great strength and adjustability as to backlash.

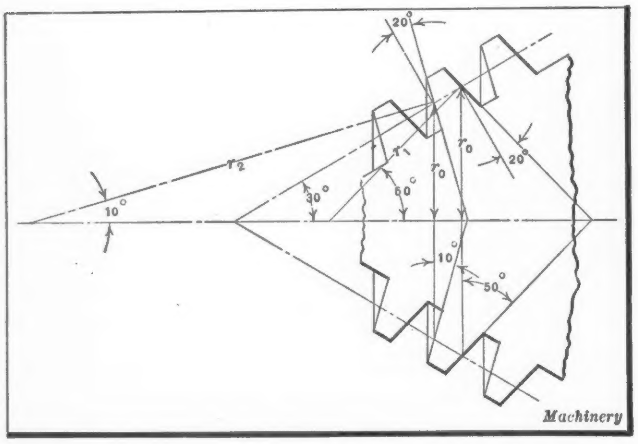


Fig. 1. Diagram representing Section of Taper Hob of Type used for cutting Spiral Bevel Gears

more nearly theoretically correct than any so far produced in the art of the spiral bevel gear cutting.

Fundamental Principles of New Spiral Bevel Gear Hobbing Process

It occurred to the writer several years ago that if it were possible to hob bevel gears at all, the gears should be of the spiral tooth type. Furthermore, the spirals should be longitudinally twisted in such a manner that they would mesh with a straight rack element of *constant pitch*. It has been shown repeatedly in technical literature that straight-toothed bevel gears cannot be successfully hobbed. From theoretical considerations it may be stated that the only criterion determining the possibility of hobbing a gear of any description is whether or not the gear will mesh with a worm. If it will, then the gear may (theoretically) be hobbed, first by making a steel helical cutter an exact counterpart of the worm, second by bringing this cutter in a tangential relation with the gear blank and rotating both elements in a timed relation, and third by giving a relative feed movement or a movement of translation to the cutter in the common tangent plane. A straight-toothed bevel gear, however, will not mesh with a worm, whether the worm be of straight or tapered form or whether it be of a constant or a variable pitch. Having thus eliminated the straight-toothed bevel gear as falling beyond the scope of the hobbing process, we may now turn our attention to the spiral bevel gear.

One feature of a spiral bevel gear is that its teeth are convex on one side and concave on the other. A second feature is that the radii of curvature are generally different at different portions of the longitudinal spirals, unless these spirals are portions of a circular arc (in development), which latter is the characteristic of the Gleason gear.

Now in order to mill a concave surface of a variable curvature, such as the concave side of a spiral bevel tooth, it is evidently necessary to use a convex milling cutter, the radius of curvature of which must always be less than the radius of the surface to be generated at any point. Similarly, a convex surface might be milled with a concave cutter having a greater radius than the surface. On the other hand, the radii both of the convex and the concave sides of a spiral bevel tooth are equal for equal pitch cone radii. From this it follows that a hob in order to mill such teeth must have a non-symmetrical thread; that is, one side of the thread should be concave, having a comparatively large radius, to operate on the convex side of the gear tooth, while the other side should be convex, having a comparatively small radius of curvature, to generate the concave side of the tooth. For this reason, the employment of the well-known spur hob for spiral bevel gears is impossible, because such a hob has the same radii of curvature on both sides. The problem has narrowed itself down, therefore, to an analysis of the tapered hob, as the peculiar property of the thread of that hob is that its radii of curvature are different on opposite sides of the thread.

Tapered Hob Used for Hobbing Spiral Bevel Gears

Suppose that a tapered hob of constant lead is constructed, the cone angle being 30 degrees while the pressure angle is only 20 degrees. Furthermore, let the thread be so cut in the conical blank that the axial section is a true rack, the pitch line of which is parallel to the side of the cone. It is evident that we have produced two surfaces on the opposite sides of the teeth, a concave one having a large radius, and a convex one having a small radius. Fig. 1 shows the method of determining the approximate lengths of the radii of curvature. The side of the thread facing the apex may be approximated by a flat hollow cone, the back cone radius of which is

$$r_2 = \frac{r_0}{\sin 10 \text{ deg.}} \qquad (1)$$

while the back cone radius of the convex side is

$$r_1 = \frac{r_0}{\sin 50 \text{ deg.}} \qquad (2)$$

where r_0 is the pitch radius of the hob at the two points indicated by the diagram. Therefore, $r_2 = 5.758r_0$ and $r_1 = 1.305r_0$; hence, the concave side has a radius about $4\frac{1}{2}$ times greater than the convex side. Thus, if $r_0 = 1$ inch, the radius of curvature of the gear tooth being hobbed may vary from 1.305 inches to 5.758 inches before interference or mutilation begins. It is seen that this arrangement answers the purpose very well, as it permits of a considerable range in the radii of curvature of the spiral teeth.

Fig. 2 shows a gear blank in which three cuts were made by a tapered cutter such as is shown diagrammatically in Fig. 1. In order to bring out the characteristic feature more clearly, this cutter was made without a helical lead, the teeth extending around the cutter circumferentially. However, the blank was correctly rolled over the cutter according to the Bilgram principle, so that the transverse contours were fully generated along the normal helix *b*. This experiment was made before the new process of hobbing was fully developed and served to demonstrate that a tapered hob of the indicated dimensions would not mutilate the spiral bevel teeth. It is of interest to note that the cutter radii on the side for finishing the concave sides of the teeth are much shorter than the radii on the side for finishing the convex sides, and in that respect the experiment fully confirmed the theory regarding these radii.

In Fig. 3, a tapered hob of the new type used in the spiral bevel gear hobbing process is shown. This hob is similar to the common spur hob except that it is tapered. Thus, in making it, a truncated tapered worm is milled first in a milling machine and then gashed lengthwise; the remaining portions of the thread are relieved in a special

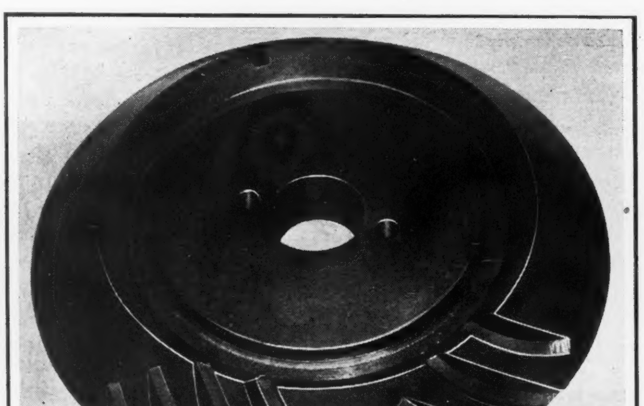


Fig. 2. Gear Blank in which Crescent Shaped Cuts have been generated by using a Conical Type of Fly Tool

relieving machine, after which the hob is hardened. Such hobs may also be ground all over after hardening, and a precise cutting tool may be obtained without encountering any unusual difficulties.

The hob has a single thread, a pressure angle of 20 degrees, and a cone angle of 30 degrees. It is provided with a tapered hole and a slot in the large end for driving. A threaded ring engages a threaded boss by which means the hob may be tightly clamped to its driving arbor. A number of equally spaced radial gashes are milled lengthwise in the hob. As the teeth are relieved by a radial movement of the relieving tool perpendicular to the side of the pitch cone it follows that the rack teeth will retain their correct form and spacing after repeated sharpenings—that is throughout the life of the hob. The rack teeth of the hob are symmetrical with respect to the line perpendicular to the side of the cone.

Mathematical Principle upon which Hobbing Process is Based

It has been shown that a tapered hob might be used for hobbing spiral bevel gears, provided a suitable spiral for the gear teeth can be found that will correctly mesh and operate with the hob spiral. It is evident that the gear spiral cannot be selected at random. The form of the hob thread, together with the necessity of avoiding the mutilation of the teeth, imposes such restrictions upon the selection of the gear spiral that the problem cannot be approached in any other way than by a protracted mathematical analysis. It would be beyond the scope of this article to enter into a detailed discussion of that purely mathematical reasoning that led to the discovery of the new tooth spirals, calculated to be conjugate with a tapered hob of constant pitch. We will merely point out the successive stages of that reasoning, and graphically prove the correctness of the result.

A characteristic feature of a tapered hob of constant pitch is that it has a variable helix angle. Also, when the pitch surface of a hob of this kind is developed into a plane, the thread of the hob presents a series of curves, and not straight lines as is the case with the common spur hob. In particular, the development of the pitch surface of the hob is a circular sector (see Fig. 4) in which the hob thread forms a series of segments of spirals of constant lead (the so-called Archimedean spirals), while the

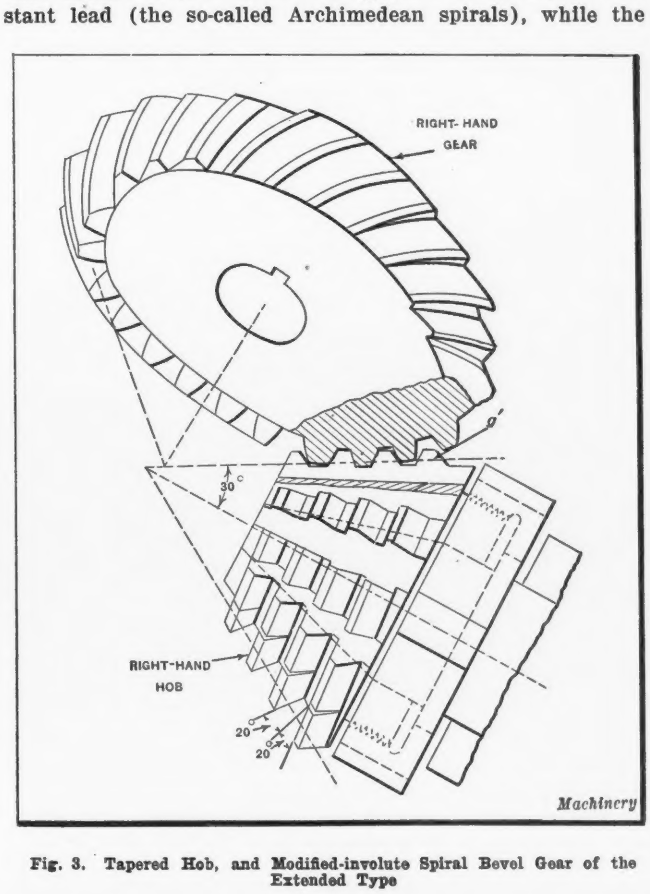


Fig. 3. Tapered Hob, and Modified-involute Spiral Bevel Gear of the Extended Type

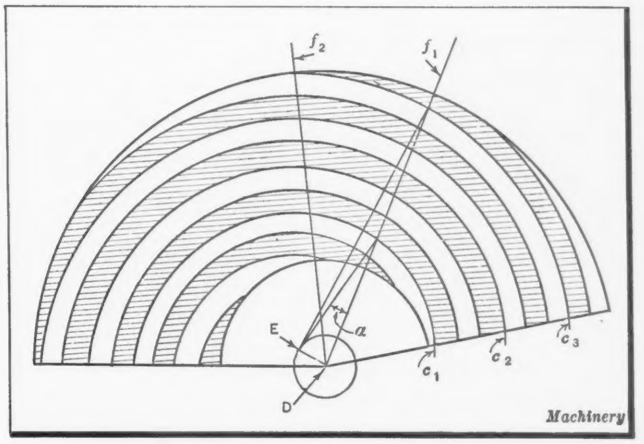


Fig. 4. Plane Development of a Tapered Hob of Constant Lead

axial rack sections (the gashes) became radial lines converging in the apex D. It can be proved mathematically that if we erect at the points of intersection of the spirals c_1, c_2, etc., with any radial line f_1, a series of straight lines perpendicular to the spirals at those points, all those lines will meet at the same point E. Further, point E lies in a line perpendicular to the line f_1. If the location of the point E is known, then the helix angle of the hob may be determined easily from the following formula:

$$\tan a = \frac{\text{distance } ED}{\text{pitch cone radius of hob}}$$

Thus, the new spirals for gear teeth must have the following three properties: (1) They must be equally spaced along a straight line. (2) The spirals must intersect this straight line at variable acute angles. (3) The variation of these acute angles must be the same as the variation of angle a. That is, the tangent of angle a must be expressible at a ratio formed by dividing a constant distance by the length of the line of equal spacing referred to, or by the rack generator. There are only two curves that satisfy these requirements: One is the *extended* involute of a circle, while the other is the *abridged* involute of a circle.

A spiral crown gear of the extended involute type is represented in Fig. 5. The graphical generation of these curves will now be described. First, draw a base circle of radius a, and a tangent to it g. Then draw another line g' parallel to g at a distance $p = ED$ ($= ED$, Fig. 4), and on the line g' equally space the points H_1, H_2, H_3, etc., corresponding to the desired pitch. Now, if line g were rolled on the circumference of the base circle c without slipping, and if line g' moved as if it were rigidly attached to g, the points H_1, H_2, etc., of the line g' would describe extended involutes.

The extended involute is an interesting curve. It is somewhat similar to the ordinary involute, with the exception that for otherwise similar dimensions it is much flatter near the base circle. Thus, the curve has what is mathematically termed a point of inflexion situated not far from the base circle, at which point the curve reverses its shape and turns from concave into convex. While in this new gearing we never use the curve in the neighborhood of that point, yet the fact remains that these curves have a comparatively long radius of curvature at the small end of the gear.

Now we come to another interesting property of the extended involutes, which makes this hobbing process possible, namely, that the lines perpendicular to the curves at the equally spaced points H_1, H_2, H_3, etc., on the rack generator g', all meet at the same point E'. This fact may be verified mathematically, although it is also kinematically evident from the method of generation, because when the line g rolls without slipping on the circle c, the center of instantaneous rotation must always be at the point E', which is the point of tangency with the base circle. Therefore, the curves described by the points H_1, H_2, etc., for that instant are small concentric circular arcs having their center at E';

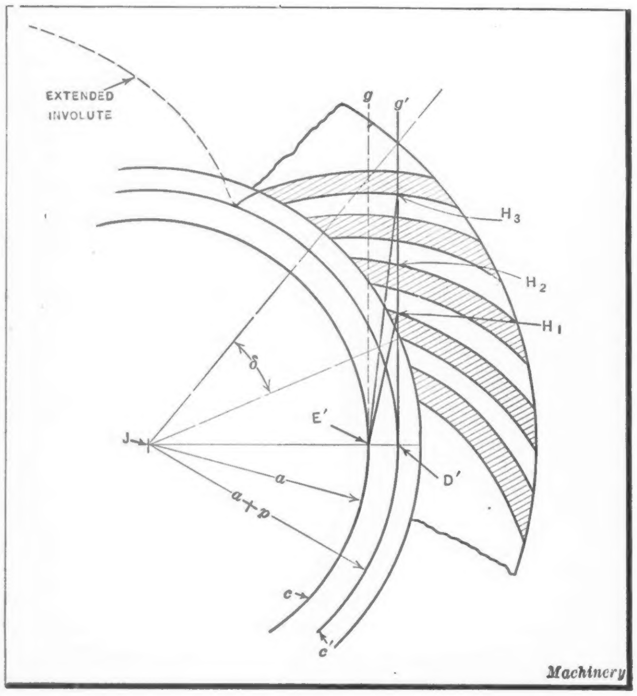


Fig. 5. Portion of a Crown Gear of the Extended Type

consequently, the normals to the curves, $E'H_1$ and $E'H_2$, etc., all must pass through E'.

The development of the hob (Fig. 4) will now be compared with that of the proposed spiral bevel gear (Fig. 5). In order to facilitate the comparison, these two developments have been correctly superposed in Fig. 6 by placing the points D and E, Fig. 4, over the corresponding points D' and E', Fig. 5, and the hob rack generator f_1 over the gear generator g'.

Referring to the illustration, Fig. 6, the following striking peculiarities will be noticed:

(1) The hob spirals are tangent to the gear spirals at all points along the rack generator g'. (2) The base circle of the hob (circle of ED radius) is tangent to the base circle of the gear. (3) When the two developments are rotated about their respective apexes D and J at a constant ratio in such a manner that their base circles roll together like two toothed wheels, the curves continue to remain in constant mesh. (4) The line of action g' is always fixed and is perpendicular to the line JD connecting the two apexes.

This shows that we have discovered two conjugate forms of a hob and a gear, the plane developments of which, when correctly superposed, are capable of continuously meshing at a constant ratio and have their points of contact localized in a fixed line. Evidently then, we may wrap one, or both of those developments on cones, and the engagement will still remain correct. In other words, we have discovered a new combination in gearing, the bevel worm drive, in which a tapered worm of constant lead meshes with a spiral bevel gear. As shown in Fig. 6, the engagement is purely sliding, because the curves, as indicated by the arrows, move in directions opposite to each other. However, as will be shown later, the sliding of tooth curves may be reduced (and the so-called "rolling element" increased) at will, by manipulating the ratios of the base radii, and the hand of the spirals.

That the two base circles c and c_2 actually roll on each other without sliding when the two sets of spirals mesh, may be proved briefly as follows: When the line g (carrying with it the line g') rolls on the circle c, the points N_1, N_2, N_3 describe extended involutes. However, when the same line rolls on the circle c_2, the same points describe Archimedean spirals. It will be seen, therefore, that the two sets of curves are conjugate in the same sense as two such curves would be conjugate in spur gearing. In that case, however, the circles c and C_2 would be considered pitch circles, and as such, naturally would roll together.

In Fig. 7 a spiral crown gear of the abridged involute type is shown. The only difference in the method of generating these curves, as compared with those of the extended type, is that the rack generator g'' is inwardly offset from the rolling line g. The curves are largely of theoretical interest only, as in the method of gear cutting here described it has been found desirable to generate extended involutes exclusively on account of the fact that a more favorable cutting action is obtainable with that arrangement.

However, a close scrutiny of the latter development affords an opportunity to broaden the theory regarding the possibilities concealed in this new class of gearing, because the crown gear development as shown in Fig. 7 is superposable upon the crown gear in Fig. 5, or upon the hob development in Fig. 4, in such a manner that the corresponding points E and D and the rack generators coincide, while the base circles touch. Then the two developments may be rotated at a constant ratio and the correct meshing of curves maintained. If we denote the distance $p = ED = E'D' = E''D''$ as the *modification*, and the new spirals (the extended and the abridged involutes and the Archimedean spiral) collectively as the *modified involutes*, we may state the following law:

Two spiral bevel gears of the modified involute type will generally mesh with a rolling and sliding engagement (like a worm and a worm-gear) provided that (1) they are generated by the same rack generator (having the same pitch and pressure angle); (2) the modifications are the same in absolute value; and (3) they are so assembled that their base circles touch each other and the modifications are superposed, in development.

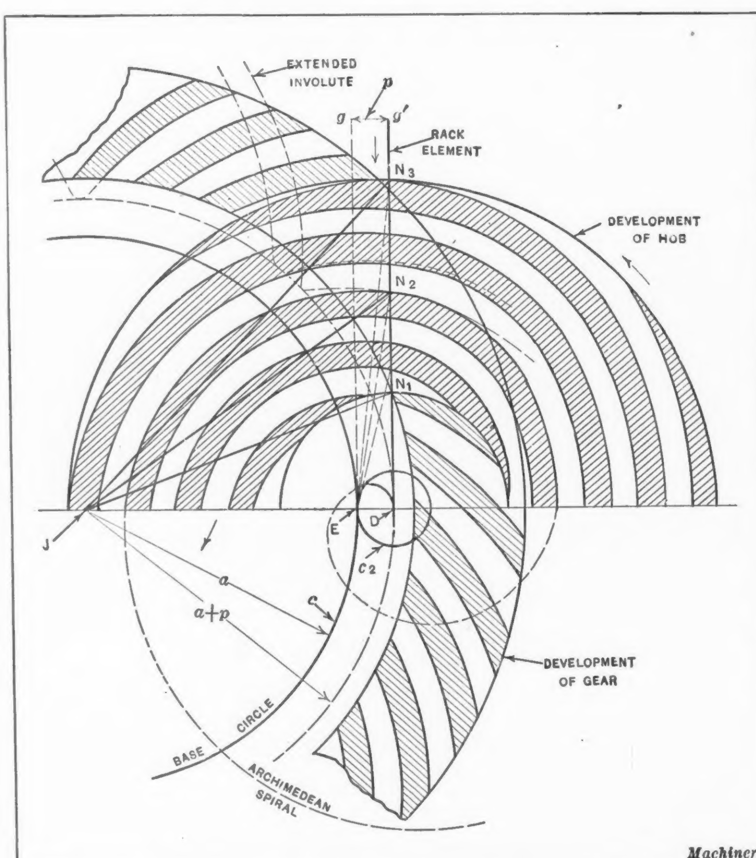


Fig. 6. Correct Superposition of the Hob and Gear Developments in the Common Tangent Plane

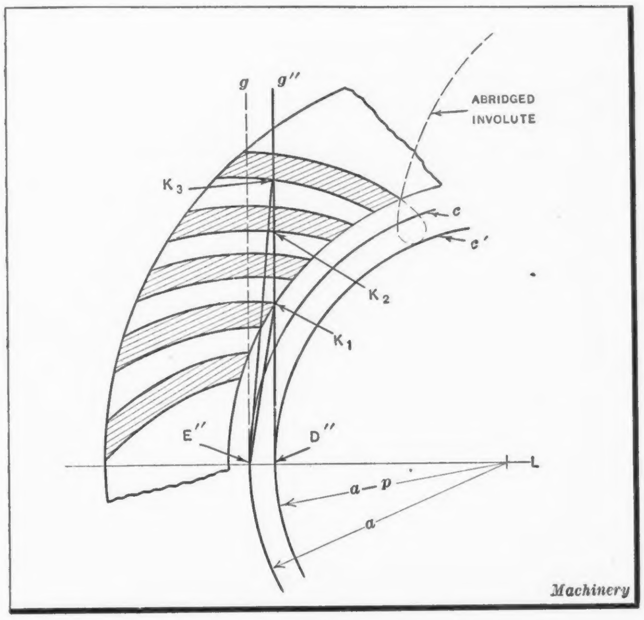


Fig. 7. Portion of a Crown Gear of the Abridged Type

Characteristics of the New Spiral Bevel Gear

In Fig. 8 is shown in perspective a portion of a gear of the extended involute type, of a form that might be generated from the development shown in Fig. 5. In that development, as already stated, the longitudinal curves are traced by the points of the offset rack generator g' when this generator is moving parallel to and together with the involute generator g. The sides of the teeth (crosswise) in the crown gear are straight lines and are complements of the generating rack along the line g'.

A conical blank if made of some plastic material, might be generated from the crown gear shown in Fig. 5 by the Bilgram process; that is, it could be rolled over the crown gear without slipping while its pitch cone apex J' (Fig. 8) was placed upon the crown gear apex J. In that case, the extended involutes passing through the points H_1, H_2, H_3, etc. (Fig. 5), become twisted spirals, l_1, l_2, etc. (Fig. 8), while the straight-line rack generators also become spirals, only twisted in a different fashion from the tooth spirals. The transverse curves of the teeth are conjugate to the rack element g' when this element is rolled over the last-named spirals m, which might be termed the geodesic helixes drawn on the pitch cone.

These helixes m play an analogous part in this system of gearing to the well-known normal helixes in the common helical gearing, in that they intersect the teeth along the loci of equal spacing, are straight lines in development, and are traced on the pitch surfaces by the rolling of the imaginary straight rack element when two such gears are in mesh. However, they differ from the well-known normal helixes in that they intersect the rack elements at constantly increased acute angles, from the small toward the large end of the gear, as formerly stated. Owing to the variable normal curvature of these helixes, the transverse contours of the teeth are generally different at the small and at the large ends of the gear. On crown gears, however, they are the same at all points, and are straight lines.

To the practical man, gears of this new kind should appeal for several reasons. They may be generated rapidly, economically, and correctly. The teeth are of approximately the same cross-section all over, and have, therefore, an equal strength everywhere. While the end thrust is considerable, owing to the pronounced twist of the helix, this thrust is not much greater than in other types of spiral bevel gears. On the other hand, the increased helix angle insures a more complete overlapping of the successive teeth, and hence, other things being equal, is bound to result in more quiet running gearing.

Owing to the fact that the new tooth surfaces are of the involute character in both directions (lengthwise and crosswise), there is considerable latitude permissible in assembling a pair of such gears. As the depth and thickness of teeth are constant, they may be measured and inspected readily by means of the well-known tooth caliper and depth gage. The latter fact also makes the adjustment and the operation of the hobbing machine easier and more accurate. Only two hobs are required for each pitch—a right-hand hob for the right-hand gears, and a left-hand hob for the left-hand gears. With these hobs, gears of any cone angle, helix angle, and numbers of teeth may be produced. Owing to the fact that the depth of teeth is parallel, the outside, the pitch, and the root cone angles are all the same, which renders the design and calculation easier. Long addendum and stub teeth may also be produced, as well as teeth having various pressure angles.

Method of Generating New Spiral Bevel Gears

It has already been shown that the development of a tapered hob of constant pitch is superposable upon a crown gear of the modified involute type (see Fig. 6) so that there is a correct engagement at all times between the two along their common rack generator. A closer inspection of these two developments will also show that while there is full tangency along generator g', there is also an interference and crossing of the curves farther away; hence it might be supposed that this method of gear-cutting is not theoretically correct as the developments show a secondary contact and consequent mutilation of tooth surfaces. This, indeed, would be the case if both the gear and the hob were crown gears. However, in this method we always employ a pinion-shaped hob, having a cone angle usually of 30 degrees. As already explained, this (together with the pressure angle ranging from 15 to 25 degrees) sufficiently increases the normal radii of curvature of the hob thread on the concave side, and decreases them on the convex side, so that the hob has a localized area of contact along the line g' without the secondary interference mentioned. Naturally, if it is possible to cut a crown gear by means of a hob without mutilation, it is also possible to cut any other gear meshing with this crown gear, without mutilation.

When the hob and gear are in position for cutting, the apex of the hob is at D (Fig. 6), while the apex of the gear to be cut is at J. In order to understand the principle of generation, let us first wrap the hob development upon the surface of the hob pitch cone in such a manner that the cone will be above the plane of the paper, the apex of the cone remaining at D, while the side of the cone touches the plane of paper along the line DN_2. Let us also wrap the gear development upon a cone lying below the plane of paper, and touching this plane along the line JN_2. The pitch cones of the two elements will now touch each other

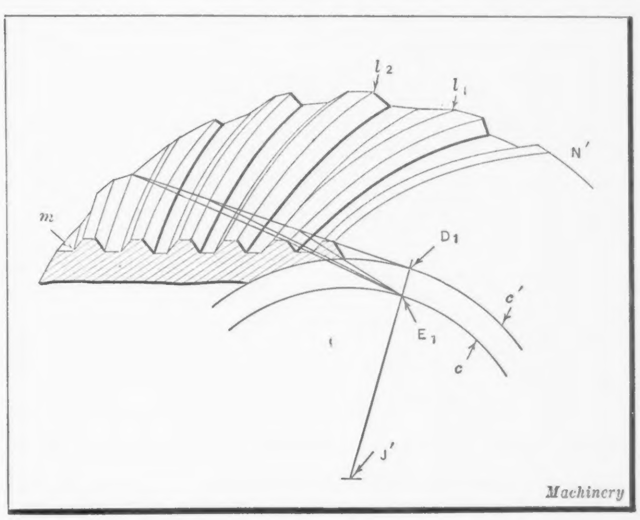


Fig. 8. Portion of a Spiral Bevel Gear of the Extended Involute Type

at the point N_2, and if both are rotated in the reverse ratio to their respective numbers of threads or teeth, they will mesh correctly with a sliding engagement, and will have a point contact at N_2. It will be seen that the timed rotation alone is not sufficient to complete the entire face of the gear blank. In order to generate the whole width of face, the point of contact between the pitch cones of the hob and the blank must be gradually (as the cutting progresses) shifted from N_1 to N_3—that is, through an angle N_1JN_3, about the gear apex J. Thus, the process of generation consists of the following three steps:

1. Adjust the hob and the gear blank on their respective arbors so that, first, they are both tangent to a fixed plane on opposite sides of this plane; second, the line of tangency of the pitch cone of the hob with the fixed plane is at a distance $a + p$ from the gear apex; and third, the hob pitch-cone apex lies on the circumference of the $a + p$ circle.

2. Rotate the hob and the blank in a timed relation, the ratio of rotation being determined by the number of teeth and the relative feed.

3. Feed the hob in the tangent plane along a circular arc concentric with the gear apex. The feed is preferably arranged so that the large end of the hob enters first, finishing the large end of the blank at the point N_3, after which the cut gradually progresses toward the small end of the blank or toward the point N_1. When the point N_1 is reached the blank is fully completed.

It is understood that the face of the hob is sufficiently long to cover completely the width of face of the blank from its small to its large end, that is, from N_1 to N_3. That fact makes it unnecessary to feed the hob longitudinally or along its axis.

Fig. 9 shows two projectons of the hob and the blank when the machine is set up preparatory to generating a right-hand miter gear. Figs. 10 and 11 also illustrate a similar gear-cutting operation. A right-hand hob of the required pitch is placed on the cutter-arbor and is then adjusted *to the right* (looking from the large end of the hob toward the center of the machine) a distance $a + p$ (the sum of the base radii of the gear and of the hob), Fig. 9, from the center line of the machine. The cross-slide seen in Fig. 11 is used in making this adjustment. The hob is next adjusted lengthwise so that its pitch apex coincides with point D, Fig. 9. As shown in the lower diagram, the two pitch cones are tangent to a common plane.

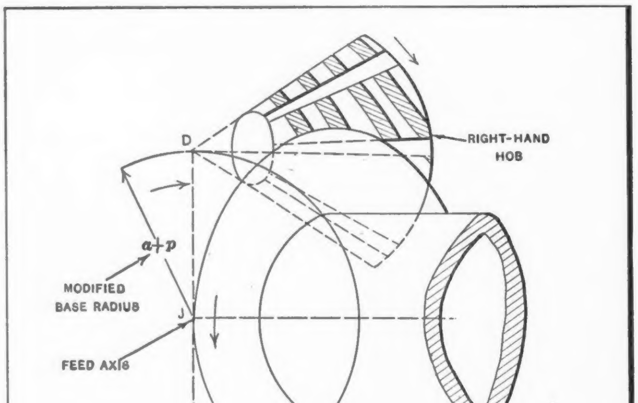


Fig. 9. Right-hand Hob in Position for generating a Right-hand Miter Gear

How to Find the Base Radii of the Hob and Gear

From the method of generation of the modified involutes (including the Archimedean spiral) as shown in developments Figs. 4 to 7, it follows that the involute generator g rolls on the base circle of a radius a without slipping. From this fact the base radius may be calculated, provided the pitch of the gear (measured along the rack generator) and the number of teeth in development are known.

Let P be the diametral pitch of the rack element g' and N the number of teeth in development. Then the base radius of the spiral bevel gear is evidently equal to the pitch radius of a spur gear having N teeth of P pitch. Thus,

$$a = \frac{N}{2P}$$

On the other hand, the number of teeth in development in all bevel gearing (whether straight or spiral toothed) is equal to

$$N = \frac{n}{\sin B}$$

where n is the number of teeth in the bevel gear, and B is its pitch cone angle. Hence,

$$a = \frac{n}{2P \sin B}$$

An example will show clearly the method of figuring. For instance, what is the base radius of a miter gear of 6 normal diametral pitch, 21 teeth, 45 degrees cone angle, and what is the base radius of a single-thread hob of the same pitch and 30 degrees cone angle?

$$N_1 = \frac{21}{\sin 45 \text{ deg.}} = 29.698$$

$$a_1 = \frac{29.698}{2 \times 6} = 2.475 \text{ inches}$$

$$N_2 = \frac{1}{\sin 30 \text{ deg.}} = 2$$

$$p = \frac{2}{2 \times 6} = 0.1666 \text{ inch}$$

Hence, the base radius of the gear is 2.475 inches, while that of the hob is 0.167 inch. The distance ($a + p$, Fig. 9) between the two apexes (measured in the common tangent plane) equals $2.475 + 0.167 = 2.642$ inches.

It is of interest to note in this connection that if the cone angle of the hob is selected to be exactly 30 degrees, it is easy to determine the base radius of a hob. Thus, for single-threaded hobs, the base radius is the reciprocal of the diametral pitch—one-sixth of an inch for six-pitch hobs, one-tenth of an inch for ten-pitch hobs, etc.

Machine Used for Hobbing Spiral Bevel Gears

As explained previously, the method of generation is very simple, consisting of only three rotations, namely, a rotation of the blank on its arbor; a rotation of the hob; and a rotary movement for feeding the hob in the tangent plane along a circular arc concentric with the pitch apex of the blank.

Were it not for the necessary angular adjustments, both of the blank and the hob, a hobbing machine of this kind would be no more complicated than the type commonly used

for hobbing spur gears, because the process is fully analogous to ordinary hobbing. As a matter of fact, *this machine and process may be considered as the general or generic process, of which the common spur hobbing is but a special case.* Thus by taking the apexes at an infinite distance, the conical blank and the hob become a spur gear and a spur hob, respectively, the modified involutes of infinite base radii are nothing but circular helixes (straight lines in development), while the circular feed degenerates into a straight line feed (a feed about a center at an infinite distance). On the other hand, the intermeshing relation, together with the employment of a straight rack element of constant pitch as the common generator or roller, remains the same for both systems.

A cross-section of a spiral bevel gear hobbing machine is shown in Fig. 12. This is a horizontal design whereas the machine shown partially in Figs. 10 and 11 is a vertical design. The vertical design has been abandoned in order to increase the stiffness and rigidity of the machine. While for spur gear hobbing, or even for bevel gear hobbing limited to a small range of cone angles, the vertical design is entirely practicable, as it permits of a construction occupying the minimum floor space, the arrangement becomes too cumbersome on account of the large and complicated overhead structures necessary in this kind of gear-hobber when the range of cone adjustment is considerable.

Referring to Fig. 12, the tapered hob *A* has a tapered hole, and is clamped by means of a threaded ring to its driving arbor. The hob-spindle is built into the machine so that it intersects the vertical plane at an angle of 30 degrees (the cone angle of the hob) with the result that the side of the hob facing the gear blank is always in a vertical plane. The cutter-head is mounted on the face of the large feed cylinder *B*, and pivots about the eccentrically located shaft *C* from which the hob is driven.

In the illustration, the hob is shown occupying the central plane of the machine, which can never happen while gears are being generated, because the hob must always be swiveled either to the right or the left of this central plane, depending on whether right- or left-hand spirals are being generated. The swiveling of the cutter-head about the axis *C* is effected by means of an accurately cut worm and worm-gear and a graduated dial, from which the angle of the helix may be read as closely as plus or minus one minute. The hob-spindle is also movable lengthwise, and may be clamped in any position. The lengthwise adjustment may be accurately measured by means of a micrometer screw and a dial with graduations equivalent to thousandths of an inch. It will be seen, therefore, that the hob may be accurately set in any required position in the vertical plane. When the hob is sharpened, it remains similar to the full size hob on account of its conical shape, although it becomes a little smaller in diameter. That slight variation also may be taken up and corrected by means of the micrometer screw mentioned.

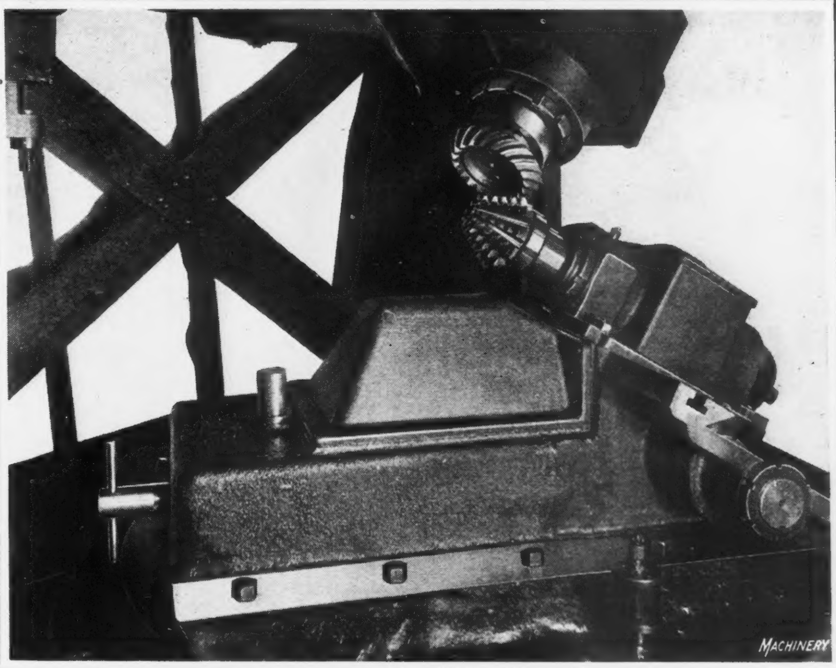


Fig. 10. Detailed View of Hobbing Operation, showing a Right-hand Hob cutting a Right-hand Spiral Bevel Miter Gear

The feed cylinder *B* is housed in the main frame of the machine and is driven by a large worm-gear *D*. This worm-gear is not directly clamped to the cylinder, but is connected to it by three large screws *E* which act as dogs in rotating the cylinder. The sides of the worm-gear *D* are accurately finished and act as thrust bearings, taking up the considerable end thrust caused by the cut of the hob. The three driving screws *E* may be released for the purpose of adjusting the depth of cut. A handwheel and a dial are provided, by means of which the feed cylinder may be moved along its axis, toward or from the gear blank, and the depth of cut may be adjusted within 0.001 inch. The hob is driven from pulley *F* through spiral bevel and split spur helical gearing, as shown. In order to transmit the rotation also to the feed cylinder and the work, an auxiliary shaft *G*, which is located at an angle of 45 degrees, transmits motion to a long master shaft (not shown in the illustration) which runs near the base, parallel to the center line of the machine.

The blank *H* to be cut is mounted on the end of a substantial work-spindle. In the design of a hobbing machine of this kind, it is essential that the axis of the spindle be always in the same horizontal plane as the axis of the feed cylinder. In order to be certain of this, the outside of the bronze bushings for the work-spindle were machined to a rectangular shape to permit using shims for making slight adjustments if required. The work-spindle is driven by means of a large split helical gear, which is keyed to it.

The work-head is mounted on top of a large semicircular table provided with a number of circular T-slots and clamping bolts, and having its center in the line with the shaft *L*. The work-head also has longitudinal adjustment by means of a suitable slide. Hence the blank may be swiveled about the vertical axis *L*, and also adjusted longitudinally so that first its pitch cone is always tangent to the vertical plane passing through the axis *L*, and second, its pitch cone apex is at the point of intersection of axis *L* with the center line of the machine.

Now, in order to generate a blank, in addition to the previously described adjustments of the hob and the blank with respect to their common tangent plane and the axis of the feed cylinder, it is also necessary to rotate at the proper ratios the three elements—the feed cylinder, the hob, and the blank. This is accomplished by three sets of change-gears and a differential mechanism.

In Fig. 13 the gear trains of this new machine are shown diagrammatically. The large feed worm-gear *D* is driven from the master shaft *M* first through a worm and worm-gear *N* and then through a set of feed change-gears *O*. In this machine the feed may be selected at will, or a hand feed may be employed without the need of recalculating the index or the roll change-gears. From the feed worm-gear *D* another set of change-gears, the roll gears *P*, lead to the differential locking worm and worm-gear *Q*. The differential *R* is of the spur-epicyclic type, and is capable of correct-

ly compounding (adding or subtracting) the two rotations, one of which is delivered from the shafts G and M to the spider, and the other through change-gearing O and P to the "sun gear." The number of teeth to be cut in the blank is regulated by a set of index change-gears S.

The following provisions are made in the arrangement of the machine and in the making of hobs to insure the maximum efficiency of cutting.

1. The right-hand hobs are made with a left-hand cut (looking from the large toward the small end of the hob) and the left-hand hobs with a right-hand cut. This makes it possible always to feed the large end of the hob first into the gear blank, and thus largely remove the burden of cutting from the small (and comparatively weak) teeth of the hob on the small end.

2. The hob starts cutting in its lowest position and always cuts on an upward stroke. The result is a positive control of the backlash in the feed cylinder because the weight of the cutter-head always opposes the feed movement.

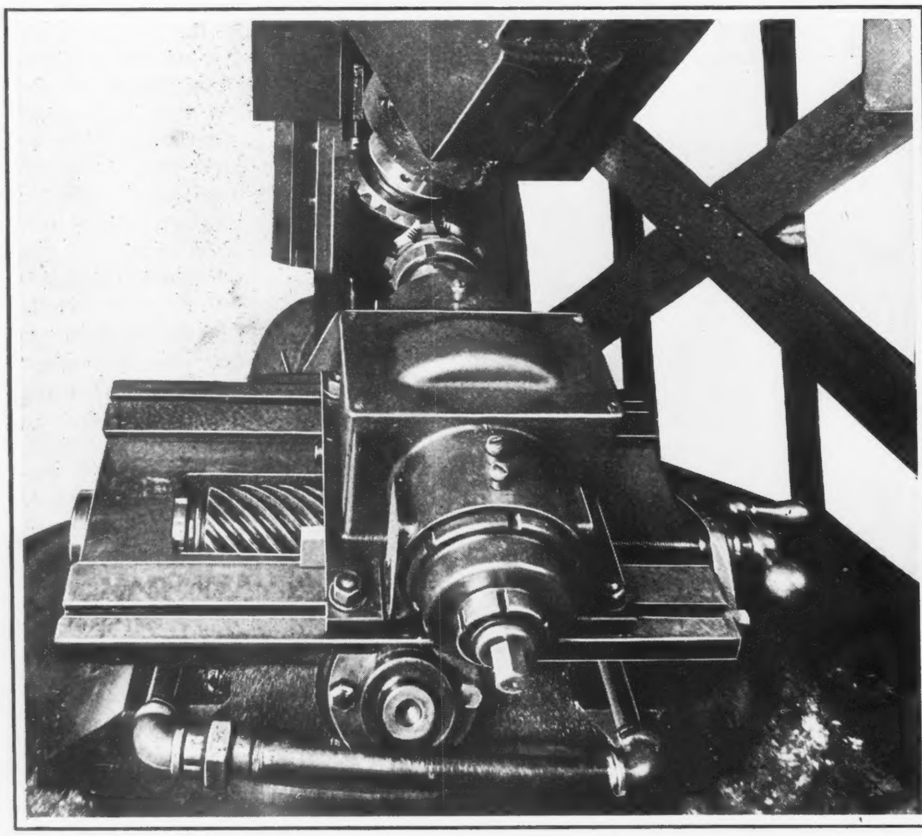


Fig. 11. Rear View of Hob-spindle of the Machine illustrated in Fig. 10, showing Rotary Feed Table and Cross-slide for locating the Hob laterally

3. The range of the angular adjustment for the blank is 180 degrees, or a half circle. Of this, one quadrant is used for right-hand gears and the other for left-hand gears.

In order to show that this method of bevel gear hobbing is theoretically correct, we have to prove the following two points: (1) When a right-hand and a left-hand crown gear are generated from similar settings by a correct method, they are entirely complementary: that is, the teeth of one completely fill out the spaces of the other. This is the well-known Sang theory, applied to bevel gears. (2) The transverse tooth contours of the gears and pinions must be generated according to the Bilgram principle, that is, by a continuous rolling movement of a rack tool about the apex of the blank. Stated in other words, the first principle requires that the longitudinal tooth curves must be identical for both the convex and concave sides of the teeth, while the second principle requires that the cross contours be rolled off from a circular rack or crown gear.

Fig. 6 shows that this method fully satisfies the first condition at the pitch cones. However, above and below the pitch line, owing to the fact that the helix angle of the hob thread is less on the outside cone than at the pitch cone or the bottoms of teeth, a slight interference is unavoidable, and a hob, as a rule, will cut a slightly opened up form in a crown gear.

The same phenomenon has been observed in ordinary gear-hobbing, and on one occasion the writer had the opportunity of analyzing and calculating the magnitude of the error from that source. It was found that the error was negligible for all practical purposes, as it amounted to less than 0.0002 inch for an 8-pitch hob, single thread, 3 inches diameter. There is no reason to suspect that the tapered hob, in this respect, would act very differently from a spur hob of similar dimensions.

The writer has cut crown gears experimentally and checked the tooth profiles along the rack section g', Figs. 5 and 6, by means of a suitable gage. The teeth seemed to be perfectly straight and if there was an error, it was less than could be detected by that method of inspection. In all other details the method is correct. As the longitudinal curves are not swept by a single stroke of a rack tool, but rather enveloped by a generating action of many tools, all having different pitch cone radii, the convex and concave sides of the teeth are exactly alike, being generated under the same conditions. In that respect the method is unique, as in past methods used for generating spiral bevel gears, the convex and the concave sides are not strictly symmetrical with respect to the center lines of the teeth.

The second condition, relating to the cross contours of the teeth, is also fully complied with in this method. The circular feed alone (about the apex of the blank) is sufficient to produce the Bilgram contours, because every tooth of the hob acts as an individual fly tool operating in its zone, this zone having the form of a narrow circular ring concentric with the apex of the blank. On the other hand, when hyperboloidal gears are cut (corresponding in this system of gearing to the worm-gears of the well known spur system—that is, requiring no special feed movement about the apex in their generation) the cross contours are, nevertheless, fully generated, as the rotary hob with its axial rack section is equivalent to a continuously moving rack element along the line g', Fig. 6, thereby producing the correct conjugate profiles along this straight line.

Finish of the Tooth Surfaces

It is a well-known fact that the ordinary hobbed surface is not a mathematically continuous surface, but is composed of a number of "flats" arranged across the teeth, and a number of "feed marks," arranged lengthwise. If a spur hob had an infinite number of gashes and was running true, it would produce continuous cross curves. If the feed was infinitesimal, the longitudinal tooth curves would be continuous. Those, however, are the ideal conditions which are only approximated in practice.

In this new method of hobbing spiral bevel gears, so far as the arrangement of the "flats" and the "feed marks" on tooth surfaces is concerned, the conditions are reversed. Thus the "flats" are arranged longitudinally, and the "feed marks" crosswise. Of these, only the longitudinal flats de-

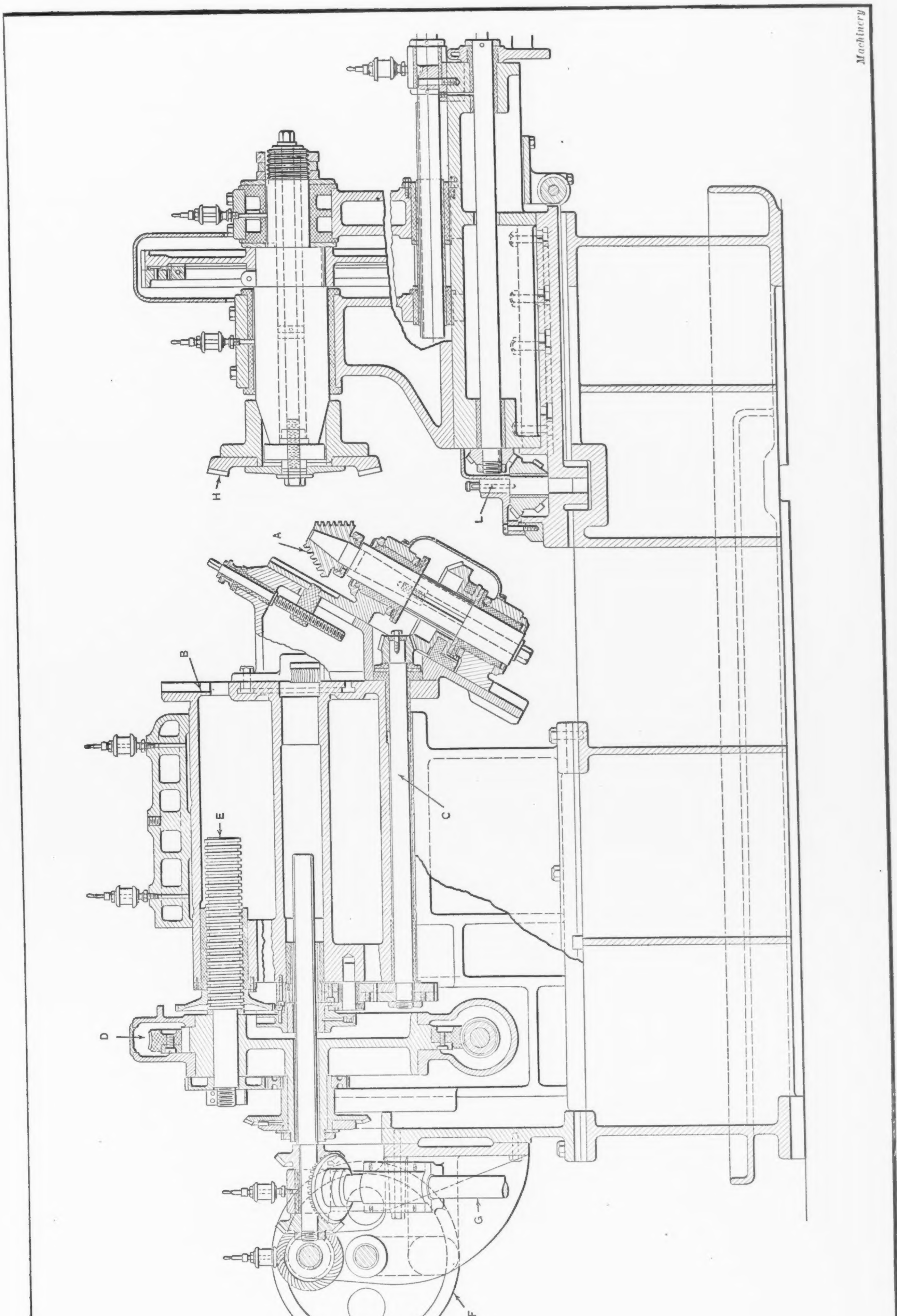


Fig. 12. Longitudinal Section of Spiral Bevel Gear Hobbing Machine of Horizontal Design

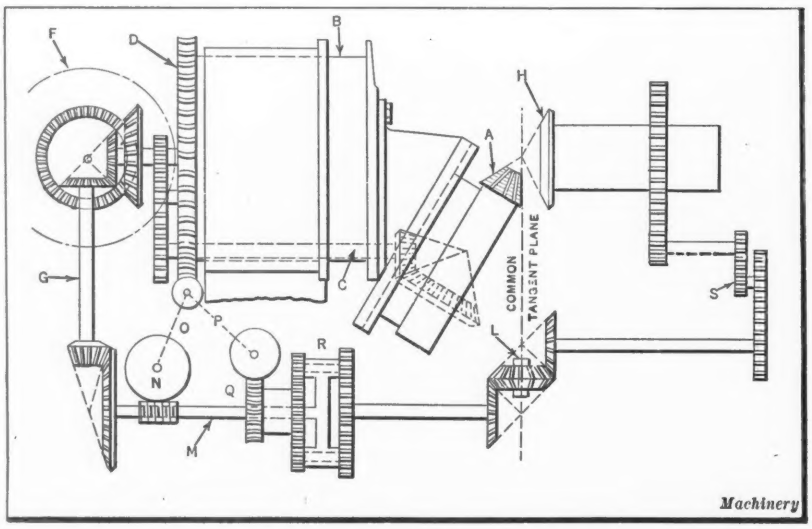


Fig. 13. Diagram illustrating Arrangement of Gear Trains on a Spiral Bevel Gear Hobbing Machine

serve serious consideration, as they cannot be eliminated by simply decreasing the feed per revolution of the cutter, which is the case with the cross contour marks. The generation of the longitudinal flats by a series of crescent shaped cuts is shown in Fig. 14. Thus if the hob runs out, the longitudinal curves in this method of gear-cutting will show a series of flats, and the completed gears will show a spotted bearing. While a longitudinally spotted bearing is not necessarily a serious defect in a gear (so long as the transverse curves are correctly formed), and while this defect automatically tends to eliminate itself as the gears wear in, it spoils the appearance of the gears and is objectionable. The only way to prevent the appearance of those longitudinal ridges or spots is to insist upon very close limits, both in the making of the hob itself and in the maximum permissible end play in the work and cutter-spindles of the hobbing machine.

. It can be proved by a somewhat lengthy calculation that if the hob were running perfectly true and if there were no errors due to end play and running out of the spindles, gears, etc., the maximum error for a 6-pitch hob cutting a typical automobile rear axle gear and pinion would be as shown in the accompanying table:

Number of Gashes	Error (Height of Flats), Inch		Length of Flats on Gear, Inch	
	Concave Side	Convex Side	Large End	Small End
10	0.000044	0.000056	0.0524	0.0267
4	0.000270	0.000350	0.1310	0.0667

The figures in this table show that while the flats are comparatively long, their height is exceedingly small. Even in the case when only four rows of teeth of the hob are cutting (spaced at right angles), the height of a flat is only from one-fifth to one-half of one per cent of its length. This is due to the peculiarities of the process, in that the curvature of the hob thread fairly well approximates the curvature of the gear teeth to be produced. Such is not the case in ordinary spur gear or helical gear hobbing, since both the gear tooth and the hob thread are convex, and the tool marks are comparatively deep. In this new process, the convex side of a hob tooth generates a concave surface in the blank, and vice versa, resulting in singularly shallow tool marks. It will be seen, therefore, that in this method of hobbing, the conditions governing the finish of the tooth surfaces are under control to at least the same extent as in ordinary gear hobbing. The more accurate the hob and the hobbing machine are, the smoother and truer the generated surfaces will be.

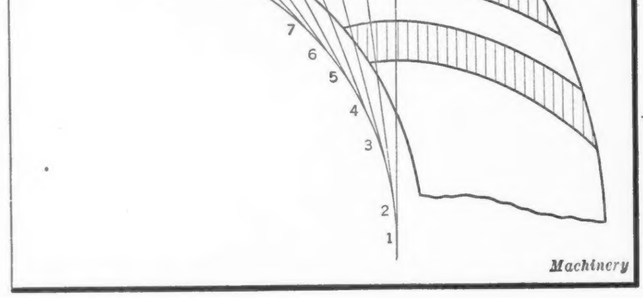


Fig. 14. Diagram representing Method of generating the Longitudinal Tooth Curves by a Series of Circular Arcs or Cuts of Constantly Decreasing Radii

In devising this method, the object sought was not so much to increase production as to produce theoretically correct spiral bevel gears, and also to solve the riddle surrounding bevel worm and hyperboloidal gearing. Incidentally however, this method, after being developed, proved to be an extremely efficient and rapid producer, and for that reason is probably destined to be one of the standard processes of the future. It will readily be appreciated that the very simplicity of the process, together with the possibility of employing a powerfully built multiple cutter, permits of great mechanical efficiency. The efficiency is comparable to that of common gear-hobbing, and is even superior to it, in certain respects. Thus there is a multiple tool engaging the blank with several teeth at every instant, a continuous cutting action evenly distributed over the entire circumference of the blank, no indexing, stopping, or reversing during the cut, a favorable formation of chips, a shearing cut, a favorable distribution of the generated heat, etc. All of these features are held in common with the spur-hobbing process.

Disadvantages and Advantages of the Tapered Hob

This new process differs from common hobbing first, in regard to features resulting from the use of a tapered hob, and second, because the blank is approached by the tool tangentially and in a circular path, instead of in the straight and axial path of feed used in common hobbing. The employment of a tapered hob has certain disadvantages, but it also has its advantages. A disadvantage is that the cutting velocity is different at different portions of the hob. Thus, a 6-pitch hob, 5 inches in diameter on the large end and 2¼ inches in diameter on the small end, will have a velocity of only 45 feet per minute on the small end, compared with 100 feet on the large end. This would be a serious handicap if it were not for the fortunate coincidence that the teeth at the large end of the hob also have to remove considerably more metal, are considerably stronger, and have more stock to be ground off in sharpening, than those at the small end. In generating, as already stated, the rotations are always so selected that first, the cut of the hob is directed against the rotation of the blank, and second, the large end of the hob enters first.

Fig. 14 clearly shows that each hob tooth cuts a crescent shaped cavity in the blank, this crescent being tangent to the opposite sides of the tooth space in its middle part and extending a considerable distance to the right and left. In Fig. 14 the cres-

cents are somewhat abridged in order to illustrate more clearly the generation of the flats *h*. It will be seen that if the large end of the hob enters first with this end acting in unison with the large end of the blank, the left portion of the first crescent removes a large amount of stock belonging to the second crescent, the second crescent roughs out the gash for the third, etc. The rack sections 1-1, 2-2, etc., are spaced about one-half degree apart, thus reducing the heights of the flats *h* to less than 0.00005 inch.

It is not easy to visualize from a description of the process alone just exactly how the cut progresses from the large toward the small end of the blank without actually seeing a machine of this kind in operation. Suffice it to say that about 90 per cent of the stock is removed by the large half of the hob cone, while the teeth at the small end of the hob only trim the gear teeth to their proper cross contours in their respective zones. Thus, the small teeth are fully able to keep up the work with the large teeth, and do not constitute a weak spot, as might be assumed by judging the process superficially.

The main advantages of a tapered hob, as compared with a spur-gear hob, are as follows: (1) On account of the conical form, the hob may be sharpened indefinitely without losing its correct form. In spur hobs, the helix angle increases when the hob is reduced in diameter by sharpening. (2) The thread of the hob more nearly approximates the tooth surfaces to be generated. From this it follows that first, the individual chips are longer, and second, more teeth are generally in cutting contact at the same instant; both facts evidently tend to increase production. (3) As the entire face of the hob wears out or dulls at an approximately even rate, such a tool has a long life in proportion to the number of cubic inches of metal removed.

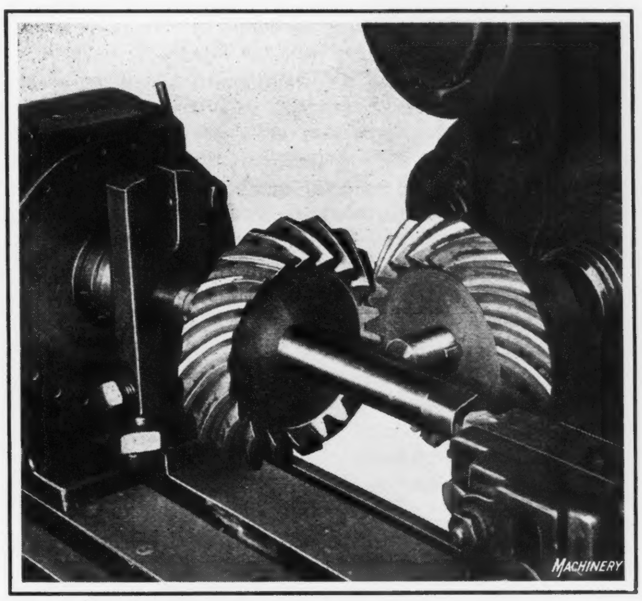


Fig. 15. Pair of Miter Gears of the Extended Involute Type mounted in a Milling Machine for testing

In judging the productivity of any gear-generating process, two aspects of the work to be performed must be considered; first, the ability to remove metal (so many cubic inches per minute or hour) and second, the ability to envelop the surface with a sufficient number of elementary flats or marks to produce a satisfactory finish. Briefly, the blanks must be roughed out and finished. For roughing, the present method will be found satisfactory because first, several teeth of the hob are cutting simultaneously; second, the diameter of the cutter is comparatively small, as is the torque in the cutter-arbor; and third, neither the blank nor the tool heats excessively on account of the continuous rotation of both.

In finishing, the conditions are almost ideal. The hob usually engages the blank with three teeth and sometimes with four at the same time (see heading illustrations), and each hob tooth cuts on both sides of the tooth space. Now if there are ten gashes in the hob and the hob is running at 100 revolutions per minute, then 60 chips are produced in each revolution of the hob, or 6000 per minute. Every one of those 6000 chips approximates the tooth surfaces at a different line. It would be difficult to conceive of anything more efficient, especially when it is considered that all teeth, on both sides and over their entire length, are finished in a single operation, without a stop.

The Bevel Worm and Hyperboloidal Gears

It has been shown that the characteristic feature of this new spiral bevel gearing is that it is capable of meshing in a dual fashion, that is, with a rolling engagement when both the pinion and the gear are generated from the same imaginary crown gear, and with a sliding or screw engagement when they are generated from two crown gears having the same pitch and modification but different base radii. Now we can go a step further and see what kind of gear will be produced if we simply sink the hob into the blank (while both the hob and blank are rotated in a timed relation), and omit the circular feed. It can be proved mathematically that in that case the pitch cone of the hob will envelop a *hyperboloid of revolution of one sheet*, while the teeth of the hob will generate spiral teeth on that hyperboloid, conjugate to a tapered screw of constant pitch.

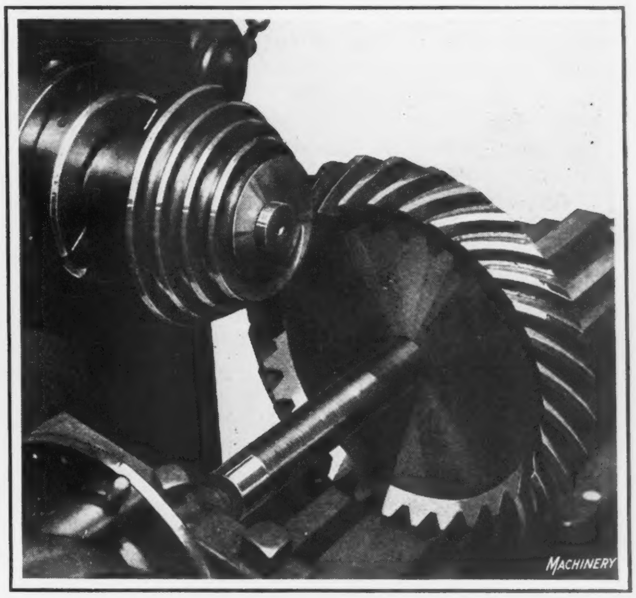


Fig. 16. A Spiral Hyperboloidal Gear meshing with a Tapered Screw; the Ratio is 30 to 1

This leads to an interesting observation which is believed to be new in the theory of gearing: The hyperboloidal gear is really nothing but a worm-gear modification of the bevel gear. That is, the hyperboloidal gear occupies the same position relative to a conical gear as does a common worm-gear to the spur helical gear. Further analogies follow: (1) The correct hyperboloidal gear has spiral teeth, while its straight-line generators are rack elements of constant pitch. (2) The tooth spirals intersect the rack elements at constantly increasing acute angles until at an infinite distance from the gorge circle the angle of intersection becomes a right angle. (3) Two hyperboloidal gears will not mesh together for the same reason that two ordinary worm-gears will not mesh. However, a hyperboloidal gear (of the spiral tooth type) will mesh with a tapered screw of the modified involute type (including a tapered screw of constant lead).

A view of the new hyperboloidal drive is shown in Fig. 16. The screw is 6-pitch, single thread, 30 degrees cone angle, while the hyperboloidal gear has 30 teeth and an angle of obliquity around 50 degrees, this angle being so calculated that the two shafts are at right angles. This pair of gears, when placed in a milling machine, ran very smoothly, and

the worm seemed to have a full line contact with the gear over the entire face of the latter. In that respect the nature of engagement was similar to that found in the so-called Hindley worm-gearing. The engagement also seemed to be free from any interference, and the contact extended from the bottom to the top of the teeth. It is believed that this type of worm drive will find considerable employment in practice in the future, because first, it is very compact and powerful for its size; second, on account of the tapered form of the driving worm, the backlash or play can readily be adjusted without changing the center distance; and third, it is easily manufactured.

It is of interest to note that a method of cutting spiral bevel gears having teeth curved along an involute was described first by H. E. Taylor of Coventry, England, in British MACHINERY, October 7, 1915. (See also articles British MACHINERY April 13, 1922, and November 30, 1922.) Also there was patented in this and other countries, a bevel gear of similar type by the Swedish inventor, E. H. Wingquist, who apparently worked independently of Mr. Taylor. (See U. S. Patent 1332151.)

Tapered hobs were used for cutting bevel gears by Bostock, (British Patent October 31, 1905) and lately Mr. Taylor and the writer, independently of each other, adopted that form of cutting tool. (See article by H. E. Taylor in *Engineering*, London, January 26, 1923.) The writer, however, claims the first discovery of the modified involute, a curve odontically conjugate to the Archimedean spiral, and also to the novel method of generating, in which the apex of the tapered hob is placed in such a position, in the tangent plane, that its base circle touches the base circle of the gear. Further, a tapered hob the teeth of which are concave on one side and convex on the other is also broadly new.

* * *

INDUSTRIAL CONDITIONS IN GERMANY

By MACHINERY'S Special Correspondent

Berlin, October 4

The beginning of October finds Germany in economic chaos. The country faces the prospect of the greatest unemployment known in its history. It is estimated that at the end of September 3,000,000 people were out of work. The industrial difficulties are due, in the first place, to the high price of coal. This high price is caused not only by the Ruhr occupation, but also by the conditions in the coal mining industry in other parts of Germany. In 1913, miners received 3.83 gold marks per worker and shift in Upper Silesia, and their average output was nearly 1100 kilograms per worker. At present, the corresponding output is only 550 kilograms, but the wages paid are equivalent to 8 gold marks. In other words, the efficiency of the worker has been cut in half and the wages doubled; or, compared with the output, wages are now four times as great, expressed in gold marks, as they were before the war. New taxes also hamper industry, and the demoralization of the currency naturally makes it impossible to make preliminary estimates of business transactions.

Conditions in the Machine-building Industries

In the machine-building field, the conditions have become more and more difficult since last spring, and during August this industry entered into a serious depression. In many plants the number of workers was much greater than required to fill the orders on hand, but, on account of the labor laws in effect, the owners could not immediately dismiss the workers who were not required, but had to reduce the output gradually by working short hours.

There are a few industries that have had fairly regular employment. In the automobile field, for example, production has continued quite regularly, and the manufacturers have been able to find buyers. The bicycle industry has also been active because of the discontinuance of service by the electric street railways. In Berlin, out of ninety car lines, only thirty were running the middle of September.

In the electrical industry, foreign orders are very few, and foreign competition is keenly felt. The shipbuilding industry suffers from lack of orders for new ships, and is occupied only on repair work. Iron ore mining has been restricted because of lack of coal and the inadvisability of mining more ore and storing it.

It is generally believed that in the machine-building industries there will be numerous failures before long. In practically every plant, the working time is being reduced, and the workers are gradually being laid off. In many instances, materials cannot be obtained in Germany. One of the large locomotive plants has found it necessary to buy sheets, tubes, steel castings, wheels, and axles from abroad.

Labor Conditions

Workers that are employed on piece-work are said to have reached the pre-war level of efficiency, but workers that are paid by the hour are said to produce only one-half of what they produced before the war. A large number of non-productive workers must be employed in every plant because of the complications in the accounting departments, where the pay-roll has to be changed daily with the rapidly changing value of the mark.

As the increases in wages have not always been able to follow the rapid fall in the value of the mark, several important strikes took place during the summer, after several months of comparatively peaceful conditions in the labor field. These strikes, however, have usually been quickly settled, because the workers lack resources for a continued strike. At the present time the manufacturers would really like to see their men go on strike, as it would be conferring a favor upon them.

One curious incident might be mentioned. The paper money printers of the state printing works went on strike. The consequences were very serious in the industrial field, because manufacturers generally were unable to obtain money to meet their pay-rolls, and when money was obtainable, it was in such large denominations that it could not be used for paying off each individual worker. Frequently four or five workers were paid with one single bill, and as the merchants had no money with which to change it, great complications arose. The difficulty increased until some of the larger firms obtained permission to print auxiliary currency to the amount of several million marks.

It is not possible any longer to speak of prices or increases in prices, because the changes take place not only daily but sometimes several times a day. Details as to prices at this time mean little or nothing, and it is useless to quote either wages or prices as expressed in paper marks. Where one formerly spoke of so many marks, one now speaks of so many million marks.

The industrial life in the Rhineland has come almost entirely to a standstill. The big works are quiet and empty. Nearly all the blast furnaces have been blown out. This condition is due primarily to lack of coal. Owing to the rapid changes in the value of the paper mark, some of the larger German concerns are now making all calculations on the basis of gold marks, and are invoicing on that basis. In order to simplify the calculations, the gold mark is assumed to be equal to one shilling or twenty-five cents. The gold mark is then converted into its value in paper marks by the rate of exchange between paper marks and pounds or dollars.

* * *

The Bureau of Standards has published its sixth progress report relating to gage steel investigation. This report covers the results obtained in measuring changes in length that take place in hardened steel cylindrical parts, and deals with internal stresses in such hardened specimens. It also covers dimensional changes due to tempering, and a brief statement relating to wear tests. Further information may be obtained by addressing H. W. Bearce, secretary of the Gage Steel Committee, Bureau of Standards, Washington, D. C.

Oxy-acetylene Welding in Railroad Car Shops

Application of the Oxy-acetylene Welding and Cutting Process to Production, Repair and Plant Maintenance

IN every large plant working on railway cars the oxy-acetylene process is being extensively used to speed up production and lower costs of operations. The plant of the General American Tank Car Corporation, at East Chicago, Ind., affords one of the best examples of the application of oxy-acetylene welding and cutting process to production, reclamation, repair, plant maintenance, and reduction of metal to scrap. This plant, not many years ago, operated only a few oxy-acetylene blowpipes. At the present time, at least fifty welding and cutting stations are in constant use, and many more will soon be put into operation. This increase in a relatively short time is due to the improved oxy-acetylene practices now employed, which have made the use of welding and cutting advantageous on practically all classes of work in the plant. Every branch of freight car construction and reconstruction, as carried on by this company, involves the use of the oxy-acetylene process.

The Oxy-Acetylene Installation

The shape of the East Chicago plant resembles an "L." Located near the center of the property is an acetylene generator house, a hollow-tile structure of three parts, the generator rooms, carbide storage room, and the oxygen manifold room. Two 500-pound carbide capacity Oxweld duplex-type low-pressure generators furnish the acetylene. Both generator units are not used at the same time, as one is usually idle or being recharged while the other is in operation. As the duplex type of acetylene generator has two generating chambers, there are really four generating units (two producing and two recharging), this practically eliminates all possibility of an interruption in the gas supply.

The oxygen supply for the entire plant is piped from manifolded cylinders in the same building. A thirty- and a ten-cylinder manifold are installed, the latter for reserve or emergency use. The operation of the large manifold is such that a constant supply of oxygen at an even pressure can be maintained at all times in the plant pipe lines. Fifteen cylinders of oxygen are in service at a time. As these become exhausted, they are cut out and fifteen full cylinders from the opposite side of the manifold are cut in. Master regulators and gages on the manifold system regulate the line pressure.

Radiating at right angles from the generator building are the oxygen and acetylene mains. Branching off from these in many directions, the piping reaches every part of the plant by lines placed underground and overhead, from building to building, on welded pipe trusses. This network of piping is at least 15 miles long, and the station most distant from the generator house is 1¼ miles away. The acetylene lines range from 2½ to 4 inches in diameter, and the oxygen lines from 1 to 1¼ inches in diameter. The lines are all welded, jointless and leakproof, and only cost a fraction of what a screwed-joint piping system would cost. Fig. 1 illustrates a section of the lines and what can be accomplished with welded joints on a two-way system.

The stations differ according to location and requirements. In shops where new cars are built, they are fastened along the walls or along the craneways. In yards where construction work is carried on, small houses of the type illustrated in Fig. 2 are used; while in other yards, where the stations might be damaged by falling parts, as when cars are being demolished, they are placed out of the way, usually between tracks below the ground level, in suitable cement or wooden boxes. Each station includes a hydraulic back pressure valve connected to the acetylene line, and a special oxygen terminal valve connected to the oxygen line.

Two men are on constant duty attending the generators and transferring full and empty oxygen cylinders. The generating room floor is below the ground level, while the floor

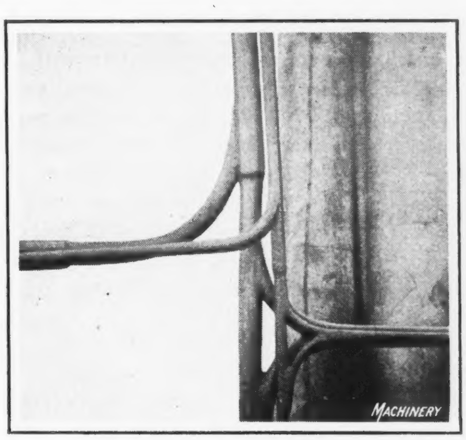


Fig. 1. Oxygen and Acetylene Pipe Lines having Welded Joints

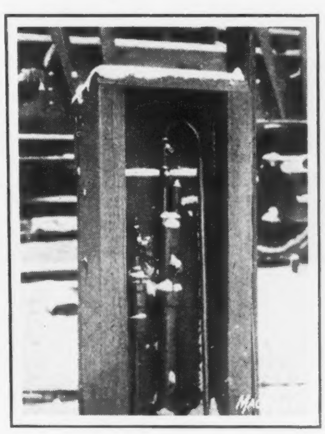


Fig. 2. Out-door Station for Oxygen and Acetylene Supply Valves

Fig. 3. Cutting Bolt Holes in Salvaged Parts for New Requirements

Fig. 4. Three-hundred Air-brake Cylinders saved from the Scrap Heap by welding on Flanges

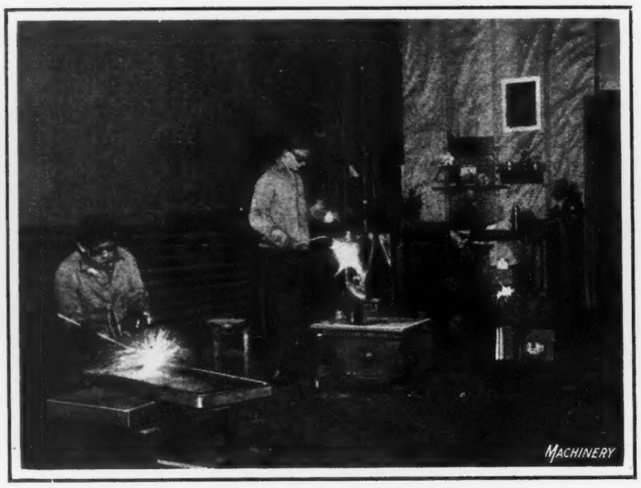


Fig. 5. A Corner in the Central Welding Shop where Work is sent to be repaired from all over the Plant

of the carbide storage room and oxygen manifold rooms are at loading level. An interesting feature of this generator installation is the method used to clean the sludge pit. A compressed air line is opened at the bottom of the pit. This agitates the sludge (mixing the slaked lime and water) which makes it easy to pump the liquid sludge into a tank wagon to be carted away.

Welding and Cutting in Production

Both oxy-acetylene welding and cutting are of great importance in the production of every type of car built by this company. Modern designs for such cars, almost without exception, prescribe that at least the under part, and often the entire frame, be built of steel—for which the oxy-acetylene blowpipe is the "master tool." In fabricating the different members, assembling these into the car parts, and finally in the finishing work, oxy-acetylene welding and cutting take a large part in each step of the production program.

Construction work on new cars is progressive. The base material—castings and formed or built-up parts—is arranged along tracks on which cars, starting with only wheels, are fabricated and assembled into complete units. The cars are built up by crews in groups along the production line, who have specific duties to perform within a limited time. The crews consist of assemblers, riveters, finishers, etc., and an oxy-acetylene operator. Often the latter is made the foreman of the crew. The principal part of each operator's work is of an emergency or corrective nature. Each crew is practically dependent upon its oxy-acetylene operator to carry on and complete its part of the schedule. A misplaced rivet-hole, or a part off size, might prevent the entire crew from functioning, and would obviously break down the schedule. By being always present and able to make necessary changes, the oxy-acetylene welder and cutter is the keystone in the production of the steel cars built by this company.

As the car skeletons are completed and before the covering material (wood or steel) is added, they are rigidly inspected. Cars having any defects are shunted to crews that do nothing but corrective work. With each of these crews are two or three oxy-acetylene operators; practically every repair or change of this character that is made involves cutting or welding or both, and often heating members so that they can be bent into proper alignment.

In the forge, machine, specialty, and other shops of the plant, welding and cutting are also employed in the production of parts for use on new cars. Specialties, like bracing members for box-car sides having a bent and welded section at each end, are fabricated in the specialty shop—a department that handles a great variety of work and employs a minimum of three oxy-acetylene operators.

The company builds special types of cars which usually require a number of metal parts that are not standard parts of other cars. In making these, the oxy-acetylene process proves very valuable. The required part can be fabricated with the welding or cutting blowpipe in a fraction of the time that it would take to adapt machines to new work, and at less cost. Using the oxy-acetylene equipment for these parts also obviates the necessity of holding up routine work while machines are employed on specialties. Another advantage is the ease with which the welding and cutting blowpipe can be used; no setting up or preparatory work of any kind is required. Either the material can be brought to the oxy-acetylene station, or the apparatus can be brought to the work. There is no delay in getting started, and often the entire fabrication can be completed in one place without the delay and cost of handling several times.

Reclamation Welding and Cutting—Repairing and Reconditioning Used Cars and Parts

Certain shops and yards in the plant are devoted exclusively to repairing freight cars of all types—tank cars, gondolas, and box cars. For this work, as in the production of new cars, oxy-acetylene welding and cutting are extensively used, and these processes make it possible in many instances to repair a car economically when it could not be done by other methods. Most worn or broken parts and sections are removed with the cutting blowpipe, and if these are not repaired and replaced by welding, new parts are often welded into place.

The ability to build up and re-form metal at will, to practically any desired shape, almost wholly does away with the problem of maintaining supplies of reserve parts for all the different types of cars that may be received for repair. The flexibility of the oxy-acetylene process and the advantages afforded by the complete installation at this plant are brought to attention particularly in the car repair yards. Time and labor are not lost in transporting damaged parts to a repair shop and back. The welding and cutting is done on the job, very often with-

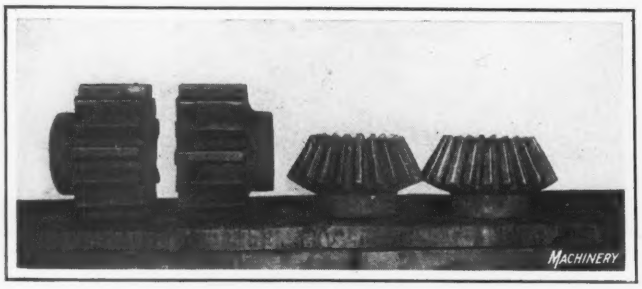


Fig. 6. Gears reclaimed from the Scrap Pile by Welding

Fig. 7. Oxygen Cylinder Trucks built up from Scrapped Pipe by Welding

out the necessity of dismantling, and always without moving the car. Bent and distorted parts of the car body and light members of the frame are heated with the blowpipe and pounded or forced into alignment.

Some cars are received in such bad order that they need to be entirely reconstructed. In such cases the cars are torn down (cutting blowpipes being used extensively) and usable parts are segregated in groups to be reclaimed and used again in reconstructing the cars. Typical parts salvaged from scrapped cars are included in the same stock. The salvage of these many different parts is a distinctive phase of the company's use of the oxy-acetylene welding and cutting process.

The cutting blowpipe is also employed in reclamation work to cut and form pieces salvaged from other parts and used to build new units. A piece cut from an old bolster may become a part in some entirely different unit. Many good sections of bolsters damaged beyond repair are collected and made into a new bolster of the built-up type. Fig. 3 illustrates the operation of cutting holes in pieces for such a part. Fig. 4 shows 300 air-brake cylinders saved from scrap by welding on broken flanges.

The Central Welding Shop

In a plant of this size the maintenance of mechanical equipment and buildings offers manifold opportunities for saving time and money through oxy-acetylene repairs and reclamation. For such work the company maintains a central welding shop adjoining its machine shop. Four operators, on an average, are kept busy on work sent to the shop from every part of the plant. Whenever possible, parts to be repaired are brought to the welding shop, instead of taking the welding or cutting equipment to the job. This practice insures the execution of the work under the most favorable conditions. In emergencies, work can be done at any place in the plant with portable outfits.

This shop, a corner of which is shown in Fig. 5, is equipped with welding tables, overhead hoists, and preheating torches, and can handle almost any job that may present itself. A track runs down the center on which heavy pieces may be carried in on hand cars. Acetylene and oxygen are supplied from the main pipe lines. When a pre-heating furnace is necessary, it is usually built in the yard, and the work is done there rather than in the shop. Broken hand tools and machinery parts such as gears, flywheels, shafts, pistons, cylinders, gear-boxes, shafting hangers, pulleys, and all parts of rivet heaters and forging machines are welded, if broken or cracked. Devices, such as belt and gear guards, hand trucks, oil waste cans, bins, racks, toolboxes, and special fittings are built by the welding shop from scrap and used materials. The welding shop does some production work during slack periods, and construction work, in emergencies, on plant equipment.

Fig. 6 illustrates what the welding shop sometimes finds in the scrap pile. The four gears with broken teeth had been scrapped. Four new ones would have cost $40, while this set was reclaimed by building up the teeth for $5.50. A similar set with welded teeth has been in use for years. On another occasion, a switch engine frame that broke in service was welded, keeping the locomotive out of service but one day.

In several instances, when erecting new buildings or changing old ones and when changing or installing machinery, the cutting and welding blowpipes have eliminated costly delays and shop work. The erection of structural steel work has often been facilitated by using the cutting blowpipe to cut and shape members of incorrect size. The small hand trucks shown in Fig. 7 were built of used pipe and old wheels. They have proved very useful in moving full carbide cans about the generator house and in transferring oxygen cylinders. A light small truck of this type enables one to place the oxygen cylinder as desired at the manifold.

Cutting for Demolition

On account of its extensive facilities for handling any sort of car work, this company wrecks a number of worn out cars, particularly steel gondolas. This demolition work is accomplished entirely with oxy-acetylene cutting blowpipes. The old cars are placed on tracks in the company's yards. The air line and air cylinder, center sills from both sides of the transom, end sills from the corners and center sills, center sill in the middle, side sills in the center, all center sill channel iron supports, and couplers are cut out, which reduces the car to scrap metal of easily handled size. Trucks are disassembled by cutting the four columns and eight oil-box bolts, as indicated in the heading illustration at the beginning of this article. The approximate cost of the oxy-acetylene operation in dismantling a car in this manner is $3.95. Various parts from demolished cars are salvaged

Fig. 8. Heating a Part to expand it so that the Pin can be withdrawn

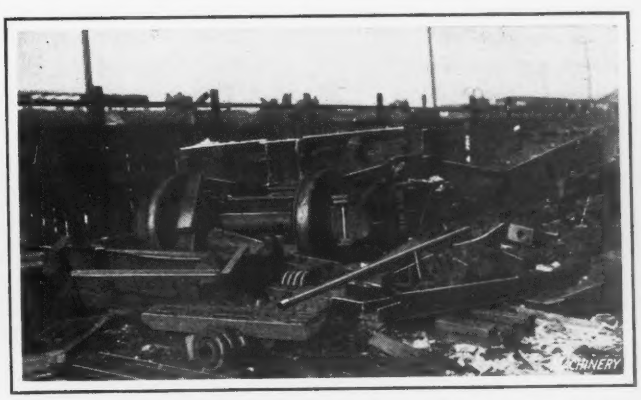


Fig. 9. A Steel Gondola Car demolished by the Oxy-acetylene Cutting Process

and reclaimed for use in reconstructed cars. Most of the metal from these cars, however, is sold as scrap.

In reclamation and repair work, and particularly in the correction of errors made in the construction of new cars, the blowpipe is often used to heat some section of metal so that it can be forced back into shape. Such parts as bent door frames, tanks on tank cars, end sills, pin-lifters, brake shafts, levers, rods, truck braces, side bars—in fact, almost every metal car section except the very heavy ones, can be straightened in this manner, and usually without the need of dismantling. When bent sheets on tank cars are straightened, it is necessary for either the operator to work inside the tank or for another man to use a sledge or jack on the inside. Fig. 8 illustrates the heating of a part to expand it so that the pin can be withdrawn.

While car construction is a specialized industry, the applications of the oxy-acetylene process at the plant referred to are of such a general character that they serve to illustrate how the welding and cutting blowpipe can be used to overcome difficulties in production, for reclamation, or for repair in any plant handling metal or metal products.

* * *

ANNUAL MEETING OF THE A. S. M. E.

The American Society of Mechanical Engineers will hold its annual meeting December 3 to 6, at the Engineering Societies' Building, 29 W. 39th St., New York City. The plans for the technical program which are being developed by the professional divisions of the society in cooperation with the Meetings Committee cover a broad field. In the field of power there will be three sessions, one devoted to heat balance and boiler-room economy, one on methods of water-flow measurement, and one on the various phases of coal storage. A joint meeting with the American Society of Refrigerating Engineers will discuss heat transfer, cooling towers, and insulation for refrigerating cars. The Machine Shop Practice Division is planning to discuss the principles of sheet-metal working. A research report in the machine tool field will also be presented. Textile mechanical engineers will discuss papers on steam distribution and woolen-mill construction; the Gas Power Session will deal with heavy oil engines; the Railroad Division will discuss steel car design and operation; and the Aeronautic Session will treat the technical problems of commercial flying. The Ordnance Division has secured the cooperation of the technical staff of the U. S. Ordnance Department, and two interesting papers are promised dealing with the advance in physical research in ordnance and the production of ordnance steel. The Management Division is planning two sessions, one devoted to the importance of good engineering as a preliminary step to the development of good management, and a second on management in the public interest.

The second Exposition of Power and Mechanical Engineering will parallel the meeting and last the entire week. As the exposition opens at noon each day, the Committee on Meetings is arranging to hold the sessions of interest to power engineers in the morning. The first exposition drew an attendance of 47,580 representative engineers, operating men and executives, as well as technical students and their instructors.

* * *

TWELFTH ANNUAL SAFETY CONGRESS

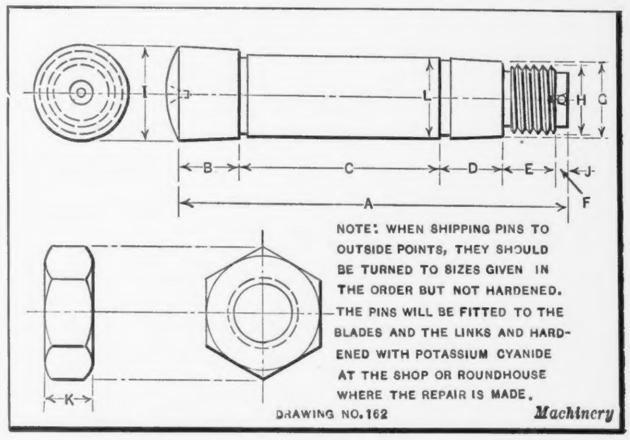
The twelfth annual meeting of the National Safety Council was held at Hotel Statler, Buffalo, N. Y., October 1 to 5. The program included papers relating to safety in the automotive, chemical, cement, construction, electric railway, marine, refrigeration, metal, mining, packing, tanning, paper, petroleum, rubber, steam railroad, textile, and woodworking fields. Two joint sessions were held—one with the American Association of Industrial Physicians and Surgeons, and the other with the New York State Department of Labor.

COORDINATING THEORETICAL AND PRACTICAL INSTRUCTION

By WARREN ICHLER

As an apprentice instructor, it has been the writer's experience that the best results are obtained only when theoretical and practical instruction are properly coordinated. The exceptionally rapid progress made by a certain class in mechanical drawing at a large railroad repair shop, for instance, may be cited to substantiate this statement. In this case the apprentices had an opportunity to make up drawings that were put to practical use in the shop. The tendency of the railroad system, of which this apprentice training department was a part, was to concentrate their mechanical manufacturing facilities at the larger shops along with the heavier locomotive and car repairs. This left only minor repairs to be taken care of at the outlying points so that comparatively small investments in stock and tools were required at the more remote roundhouses and repair shops.

While this plan has much to commend it, it has always had, and probably always will have, the disadvantage of being rather cumbersome in its details; that is, it is difficult for the small repair shops to order repair parts which are not standardized and from their nature cannot be standardized, without a great deal of correspondence and loss of time. With the best intentions in the world, round-



Type of Drawing used in ordering Repair Parts

house foremen will omit important dimensions and thereby cause a good deal of delay and questioning from the central shop where the parts are manufactured. In an effort to counteract this tendency on the part of outside foremen, and at the same time give the class in mechanical drawing some practical work, the writer had the members of his drawing classes make up small standard drawings (like the one shown in the accompanying illustration) of all the parts, or as many of the parts as possible, that were in the greatest demand at the outlying roundhouses.

The method of procedure in this case is noted on the drawings. All roundhouse foremen were supplied with these little drawings, and in ordering the parts would merely say in their letters, "Refer to Drawing No. 162 and ship part with dimension A = 6 inches, B = 1¼ inches." The complete list is sent to the central plant where the parts are kept in stock or made up as required. Any additional explanatory notes deemed necessary are also included in that letter. It is obvious that with a completely dimensioned drawing in front of him no mechanical man is apt to omit important details, and can make his meaning absolutely clear with a minimum of explanation. Upon receipt of such an order the shop manufactures the needed parts if they are not in stock, using their duplicate standard sketches as working drawings, and holding as closely to the specified dimensions as possible. It is significant that in very few cases were the parts furnished found to be unsatisfactory after this method was adopted.

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MACHINERY'S DATA SHEETS Nos. 23 and 24

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HELICAL PHOSPHOR-BRONZE SPRINGS

TABLES FOR CALCULATING HELICAL PHOSPHOR-BRONZE SPRINGS

By JOSEPH H. SULLIVAN, Springfield, Ohio

The accompanying table, Data Sheet No. 24, and the Data Sheets to follow in January and February apply to phosphor-bronze helical springs, and are calculated for a fiber stress of 60,000 pounds per square inch, with a modulus of elasticity of 6,000,000.

The Brown & Sharpe wire gage is the standard used for phosphor-bronze wire, and except where fractional sizes are used in the table, the numbers refer to the Brown & Sharpe gage.

The tables give, in the two left-hand columns, the size of the wire from which the spring is made, both by gage number and in decimals. Along the top of the tables is given the mean or pitch diameter of the spring. To find the values relating to any one spring, therefore, first locate in the left-hand columns the size of wire from which the spring is made, and then follow the horizontal line from this size to the column headed by the mean diameter of the spring. For example, assume that the values for a spring made from No. 5 B. & S. gage, having a mean or pitch diameter of 2⅛ inches, are to be found. In Data Sheet No. 24, the number 5 is located in the left-hand column, and then the lines applying to this size of wire are followed horizontally until the column headed 2⅛ inches is reached. Here we find three values given, one above the other, as follows: 64.0, 0.780, and 82. The *top value* gives the load, in pounds, required to compress the spring solid, or the total capacity of the spring. In this case 64 pounds would be required for this purpose. The *second value*, 0.780, gives the movement per coil, in inches, when the spring is compressed from its free height to solid; this value also often is known as "deflection under total load per coil." In this case, then, the deflection under a load of 64 pounds is 0.780 inch per coil. The *third value*, 82, is a "load-compression value." If this value is divided by the number of working coils in the entire spring, the load, in pounds, required to compress the spring 1 inch will be found.

The third column from the left in the table is headed "Constant." If this constant is divided by the pitch diameter of the spring, the quotient will represent the load that will compress the spring solid. This constant is used in cases where the pitch diameter of the spring is not found directly in the table, but is a value intermediate between those given at the top of the columns. For example, assume a spring having a pitch diameter of 2 1/16 inches, made from No. 7 B. & S. wire. The load that will compress this spring solid is $70.4 \div 2\ 1/16 = 34.1$.

Example 1—A spring is made from No. 4 B. & S. gage phosphor-bronze wire. It has a mean diameter of 2¼ inches and 10 working coils. What weight is required to compress this spring 1 inch? By referring to Data Sheet No. 24, it will be found that for a spring of the size wire and mean diameter specified, the value in the third line is 115, which, if divided by the number of working coils (in this case 10), gives a weight of 11.5 pounds as required to compress the spring 1 inch.

Example 2—A spring is made from No. 6 wire and has a mean diameter of 2 inches. How many coils are required in this spring to obtain a movement of 1 inch with a load of 10 pounds?

By dividing the value 64, found in the third line in the table, by the load (10 pounds) the number of working coils required is found in this case to equal 6.4.

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HELICAL PHOSPHOR-BRONZE SPRINGS

Size of Wire, B. & S. Gage	Diam. of Wire, Inches	Constant	Mean or Pitch Diameter of Spring, Inches									
			2⅞	2¾	2⅝	2½	2⅜	2¼	2⅛	2	1⅞	1¾
			128	134	140	147	155	164	173	184	196	210
¼"	0.2500	368	1.039	0.950	0.866	0.786	0.709	0.636	0.568	0.503	0.442	0.385
			123	141	162	188	218	257	305	366	445	550
			93.5	97.0	102.5	107.7	113.2	119.0	126.5	134	143	153
3	0.2253	269	1.153	1.055	0.961	0.871	0.787	0.706	0.630	0.558	0.490	0.427
			80	92	107	125	144	164	200	242	291	356
			85.8	90.0	94.0	98.6	104	110	116	123	132	141
7/32"	0.2187	247	1.190	1.085	0.990	0.896	0.856	0.727	0.649	0.574	0.505	0.440
			71	82	95	110	128	151	179	217	265	325
			....	73	77	80	85	89	95	100	107	115
4	0.2043	201	....	1.163	1.060	0.961	0.864	0.779	0.695	0.615	0.540	0.471
			....	63	70	84	98	115	137	163	198	244
			....	56	59	62	65.4	69	73	77.6	82.3	89
3/16"	0.1875	155	....	1.268	1.155	1.048	0.945	0.848	0.757	0.670	0.592	0.513
			....	45	51	59	69	81	97	115	140	173
			....	49.4	51.8	54.4	57.2	60.4	64.0	68.0	72.5	77.7
5	0.1819	136	....	1.427	1.189	1.084	0.974	0.874	0.780	0.690	0.607	0.529
			....	35	46	53	61	72	82	100	124	147
						40	42.1	44.5	47.1	50	53.3	57.0
6	0.1620	100	See Data Sheet No. 23 for directions for use of table.			1.202	1.096	0.980	0.876	0.776	0.682	0.594
						33	39	45	54	64	77	96
						28.2	29.7	31.3	33.1	35.2	37.5	40.2
7	0.1443	70.4				1.360	1.228	1.100	0.983	0.868	0.766	0.667
						21	24	29	34	41	50	60
			....	....	....	19.6	20.6	21.8	23.1	24.7	26.1	28.0
8	0.1285	49.4	....	....	....	1.524	1.380	1.240	1.104	0.980	0.860	0.749
			....	....	....	13	15	18	21	25	31	37

The British Metal-working Industries

From MACHINERY's Special Correspondent

London, October 16

WITH industry in such a sluggish state, periods of one month are not long enough in which to discern movements of either general improvement or depression. There are, however, spasmodic improvements to be noted in several districts, and it is thought that the less acute feeling in the Ruhr district will help, if only to a small extent, in bringing back that sense of security that has been absent for so long.

The Machine Tool Industry

Among machine tool makers conditions vary; in most districts there is, on the whole, little change from the dormant condition of the past months, but at the same time, there are cases of firms obtaining very welcome orders. Lathe manufacturers in the Midlands seem in a better position than those in the Yorkshire area, and in the former district turret lathe and screw machine makers are fairly busy. Light machines are generally in fair demand, and revised production schemes that are being initiated in some of the leading automobile works have improved the demand for special machines. With these and the supply of standard machines of all types, it is estimated that the automobile industry is responsible for at least 50 per cent of the present activity in machine tool works in the Birmingham district.

In general, it is the contract shops building a large range of special tools that have been most favorably placed, some, indeed, having been able to maintain a full working force on full time with occasional spurts of over-time throughout the year. It is a case where quality and reputation have stood makers in good stead. Manufacturers of presses are likely to benefit from the decision of the Royal Mint to reorganize their bronze coin department in order to make a substantial increase in the output of copper coins. Overseas business in machine tools is beginning to look brighter; Colonial inquiries are circulating plentifully, and in particular, Indian railways are actively interested in the market.

Small tool makers are generally maintaining a steady output, and firms that specialize in tooling equipment, fixtures, and jigs have a fair amount of work in progress. There is also a substantial and well sustained demand for edge tools, saws, hammers, and hacksaws. The file trade shows signs of improvement, but there is much to be made up in this particular branch before the position can be considered satisfactory.

Conditions in the General Engineering Field

In the engineering field, manufacturers of heavy electrical equipment are the most active. Such manufacturers are well supplied with orders and there are good prospects of more. In the Midlands, railway rolling stock makers are a bright spot in an area that generally shows a depressed state of affairs. Wire manufacturers and power transmission millwrighting equipment makers are not in such a bad position as most other industries. Although prominent textile machinery makers anticipate an early and rapid improvement, the industry is experiencing a dearth of orders, and this is also true of boiler makers, tank makers, and agricultural engineers. In the last-mentioned trades, the few orders obtained are usually taken at cost prices.

Gas engine manufacturers report improving conditions in both the home and overseas market. In addition to home orders, large engine orders have been booked for South America, Australia, China, the Gold Coast, and India. In the Leeds vicinity, locomotive builders have obtained sufficient orders to keep a proportion of their men employed during the winter and if, as is expected, certain home and overseas inquiries for locomotives materialize, the position will not be so serious as was anticipated a month ago.

Shipbuilding and Marine Engineering

Scottish firms have obtained contracts for new vessels during the last ten weeks, including two passenger vessels of 15,000 and 11,000 tons, respectively. Barclay Curle & Co., Ltd., of Whiteinch, are to be the builders. This is the most important order that has been received for several months. Another firm on the Clyde that has a satisfactory amount of work in hand is Harland & Wolff, Ltd., who have six large vessels on the stocks and three to lay down at Govan, in addition to several at Greenock. Apart from these two firms, very few Clyde companies have more than a single vessel in hand.

Launching statistics for the first eight months of this year show that only 72 new vessels have left the Clyde yards, the total tonnage being 148,280 the lowest record since 1887 and about one third that of the record year—1920. Well-known builders of marine engines are equipping foreign-built vessels, and these facts go to show that British marine engine builders are still able to compete successfully with those of other countries.

Overseas Trade in Machine Tools

The returns for August showed that during the month the exports of machine tools increased, as compared with the previous month, in tonnage and value; the tonnage was 1041 and the value £104,501, as against 790 tons and £81,170 for July. Imports were maintained at about the same level at which they have kept for the past year; the import tonnage was 274 with a value of £40,272. During August the value per ton of imports rose to £147, while that of exports remained round about £100.

It is interesting to note here, however, that the imports of machine tools from Germany are showing a marked increase; in fact, during the quarter ending June of this year, Germany exported to England nearly twice as much tonnage as America did, although the values were naturally less—in the ratio of about 5 to 7. The most noticeable items in which German imports exceeded those of America, in both tonnage and value, were drilling machines, lathes, and milling machines.

Materials

A firmer tone characterizes the iron and steel industries. Works engaged in the production of bright-drawn free-cutting steels, mild steel, wire and strip are working at full capacity, while the trade in crucible and electric furnace steels is much steadier. In Sheffield about 75 per cent of the basic steel furnaces are working, and the fact that many orders now being placed are showing a margin of profit, gives an altogether more encouraging outlook for the future. In Scotland the iron and steel trades do not show such encouraging signs; makers in this district are finding that home trade, in particular, is very much depressed, although export trade is slightly better. The market for pig iron remains very poor, but in some quarters inquiry is more plentiful; transactions, however, are usually confined to small lots for quick delivery. Prices of materials in some cases have shown slight reductions during the past month, although at the date of writing there is a tendency toward stabilization.

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THE INCREASING NEED FOR LABOR-SAVING MACHINERY

All manufacturers complain of a scarcity of skilled labor, and in some parts of the country, especially in the Pittsburg and Cleveland steel districts and in the automobile centers, there is a scarcity of unskilled labor as well. In the machine tool centers, the men formerly employed in the machine tool shops found other employment during the last two years when machine tool builders were unable to keep their organizations together because of reduced sales, and it is now a difficult matter to hire a sufficient number of skilled men to take care of the present volume of business. In the entire machine-building field there is a scarcity of good help because of improved conditions.

The National Industrial Conference Board reports that, according to statistics covering nearly 600,000 wage earners, in twenty-three industries, comparing identical plants, there are now 28 per cent more people employed than in July, 1914. It is evident that the only remedy for the labor shortage, is the increased use of automatic and other labor-saving equipment. The many new machines of the automatic and semi-automatic type that have recently been placed on the market, show that the possibilities of the employment of machinery to supplement and replace hand labor and hand-operated machines are not exhausted.

The machine tool builder still holds the keys of mechanical progress in his hands, for the problem of labor shortage must be solved largely by the help of improved machine tool designs.

* * *

REDUCING COSTS BY SIMPLIFYING DESIGNS

Many manufacturers have taken advantage of the slack period in business to examine closely their shop methods and effect economies wherever possible. This was especially necessary after the high-pressure war-time years, because many wasteful practices then gained a foothold. But it is not only in shop methods that economies can be effected; a careful supervision of the designs of the machines being built will often result in appreciable cost reductions, as several manufacturers have already found.

For example, in one shop where several types and sizes of machines are being built, a number of parts on one machine almost duplicate the corresponding parts on others. But as each type or size of machine was designed at a different time, possibly by a different designer, there seldom has been any attempt to make such parts exactly alike, although by making them applicable to the entire line they could have been produced more cheaply in greater quantity. This is particularly true of such parts as bushings, washers, collars, studs, handles, lock-nuts, and similar machine details. The dimensions of these parts can usually be changed slightly without in any way affecting their utility, and by such slight changes considerable economies in their manufacture can be effected.

One machine tool builder who recognized this opportunity for reducing production costs is now having the drawings of his entire line gone over, and separate drawings made of all collars, handles, lock-nuts, and other parts, the dimensions of which can easily be changed to produce uniformity. After all these parts have been collected in one drawing, they are carefully studied for the purpose of determining the best average dimensions to use for the entire line of machinery, or for such portion of it as can be served by parts of uniform dimensions. These average dimensions are then declared "standard," and every designer is expected to use these standard parts rather than to design others to suit his own fancy.

This method of standardizing machine parts as far as it applies to the line of a single manufacturer, is not new; because in some of the larger machine tool plants it has been applied for years. Many of the smaller shops, starting with one size of one type of machine, and gradually adding new sizes and types, have not taken advantage of this cost saving method; but they are now beginning to do so, with satisfactory results.

Incidentally, this is also the first step toward a general standardization of small parts for the entire machine tool industry. Where such standardization can be effected, it will result in greater economies, because many parts that are now made in small quantities in each shop can then be produced at lower cost by a parts manufacturer for the entire industry. Machine handles have been produced in this way for some years and are now made in quantity by several shops specializing in that line; but some day it will apply to other parts such as collars, washers, screws, studs, bushings and similar machine details that can be produced economically only when manufactured in quantity. There is no reason why such parts should be made by each machine tool builder in his own shop; they could be bought in the open market, if standardized, the same as taper pins and set-screws. And being free to specialize on the important parts of their machines, manufacturers could give their product even greater attention than in the past; so that the two results of standardizing the less important items, would be reduced cost and improved quality.

* * *

AN ASSOCIATION OF CONTRACT SHOPS

The American machine tool builders have an association for furthering the common interests of the manufacturers in their field, the gear manufacturers for standardizing the design and methods of producing gears, and the manufacturers of various lines of small tools for standardization in their respective fields; but the great number of special tool, jig, and fixture shops, generally known as contract shops, are not united in any organization for common interest.

The special tool shops have become an important factor in the machinery industry, but nothing has been done by them through cooperative effort to provide for standardization, to eliminate wasteful methods and practices, and, by organized effort, to win that recognition, as an important part in the general machinery industry, which has been secured by the machine tool builders, the gear manufacturers, and the makers of small tools.

The shops in the special tooling equipment field—those making gages, jigs, fixtures, dies, and special tools and machinery—would be helped and strengthened by the formation of an organization along similar lines to those mentioned above, through which useful knowledge could be distributed and practical ideas exchanged. Certainly both makers and users of machine tools have benefited by the wide variety of work done by the National Association of Machine Tool Builders, and the standardization work accomplished by the American Gear Manufacturers' Association and the Tap and Die Institute is of great value to all mechanical industries. Similar results may be accomplished by an organization of tooling equipment manufacturers.

National Machine Tool Builders' Convention

THE twenty-second annual convention of the National Machine Tool Builders' Association, held at Hotel Aspinwall, Lenox, Mass., October 2 to 4, dealt with a number of important subjects relating to the machine tool industry, and was unusually well attended. The president of the association, Edward J. Kearney, president of the Kearney & Trecker Corporation, Milwaukee, Wis., in his address, discussed the subject of transportation, which he termed "the master key to progress." J. Wallace Carrel, vice-president and general manager of the Lodge & Shipley Machine Tool Co., Cincinnati, Ohio, presented a report of the association's Dealers' Conference Committee; and H. M. Lucas, president of the Lucas Machine Tool Co., Cleveland, Ohio, gave a report of the Ethics Committee, containing a tentative draft of a code of ethics and rules of business practice for the machine tool industry. The general manager of the association, Ernest F. Du Brul, presented a comprehensive report on various phases of the association's activities.

Ralph E. Flanders, New President of the National Machine Tool Builders' Association

President Kearney's Address

In his address "Transportation—The Master Key to Progress," Mr. Kearney said in part:

"Machine tools are called, and rightly so, the "Master Tools of Industry"; but they are not a primary product, creating their own demand, or connected, except very indirectly, with individual consumption. They are the instruments necessary to the creation of machines that themselves reach the final consumer, such, for example, as carpet-sweepers, automobiles, and radio outfits, and also for the creation of machines that are many times removed from the ultimate consumer, such, for example, as the steel mills that make the rails, that carry the locomotives, that draw the cars, that deliver to the consumer the carpet-sweeper, the automobile, and the radio outfit. So it turns out that new developments to which we look to give impetus to our industry are not of our creating. When a new machine, or a more highly developed old one, presents a demand, either for greater precision of manufacture or increased production at less cost, we meet that demand and in that way make our contribution to progress.

"During the last sixty years there have been many new developments that were of such magnitude and that came forward with such a rush, that they, together with production already established, created a peak demand for machine tools. Every one of these forward movements left the industry on a higher level than before. Among the developments that have given this added impetus to the industry may be mentioned the sewing machine, the electric generator and motor, the bicycle, and the automobile."

Reaction after Post-War Boom

"The reaction following the artificial stimulus of the war and the post-war boom, when machine tools were in unusual demand, has not yet left us. The statistics that we began to gather in 1920 show that, as compared with the first quarter of that year, the business of the third quarter of 1921 was only 10 per cent, due to both reduced prices and reduced volume. The gradual improvement that has been made since shows that our factories, taken as a whole, are now working at only about one-third of their capacity. Under such conditions, it is not surprising that many of our members have been forced into receiverships, and the strongest have seen their surpluses diminish, and, in many cases, their capital impaired. There are no figures on which to base the assertion, but it is my belief that a combined financial statement of the industry made now, as compared with three years ago, would show a shrinkage or net loss of at least 25 per cent in the total net value of the industry.

"It is not known among business men generally that the machine tool industry suffers during the downward swing of the business cycle to a far greater extent than ordinary manufacturing lines, for the reason that our product is bought mainly during periods of expansion. The carpet-sweeper manufacturer, when his business shrinks 5 per cent, buys no more machine tools, so that our business, as far as he is concerned, falls 100 per cent. The example could be extended almost indefinitely. Is it therefore any wonder that we ask one another whenever we get together, 'What is the next development that will sustain the machine tool industry?' Everyone has an answer. I have mine. It is general, mechanical, industrial, and agricultural development and prosperity, with transportation, the master key to progress. Unfortunately there are certain elements in our political life that would throw the key into the well and prevent entrance into that temple of well-being—universal prosperity.

"Future progress depends on adequate transportation facilities. So important is this that it should be a matter of the most serious concern to every business man and citizen. It is this view that leads me to present an outline of the case and show where we can do something for ourselves and in the public interest. There are few people not actively connected with railways or who have not made a study of their growth, who have any idea as to the enormous extent to which transportation in this country has grown."

Increase in Passenger and Freight Traffic

Referring specifically to the development of the service of the railroads, Mr. Kearney pointed out that in 1880 the annual per capita travel in this country was approximately 100 miles, while it is now about 400 miles. Considering the increase in population, the actual number of passenger-miles covered at present is over eight times what it was in 1880. The amount of freight carried has increased even more rapidly. The per capita ton-miles have increased six times since 1880, and when the increased population is taken into account, the actual ton-miles in a year's traffic are now thirteen times as great as in 1880.

Every factor in the economic progress points to greater production, greater wealth, and higher standards of living; consequently, greater consumption, necessitating more and better transportation. There are ample grounds for the prediction that within twenty years we shall demand of the railroads the moving of twice the amount of freight carried today. In addition, they will be called on to provide for a 75 per cent increase in the passenger-miles traveled.

Continuing his address, Mr. Kearney pointed out that there will be a demand for larger locomotives, with still further developments in superheating, feed-water heaters, water rectification, increases in the heating surface of the fire-box, the development of boosters, coupled with the ever-increasing tendency toward electrification. He also dealt with the subject of brakes, and the improvements still to be made in sidings, switches, and signals, and referred to the necessity of keeping all this equipment in proper operating condition.

The Responsibility of the Interstate Commerce Commission

"The only thing that stands in the way of growth of transportation facilities is lack of capital. The capital will be forthcoming if there is prospect of security for the investment and a continued return that is satisfactory compared with what can be obtained in other industries. But the people are misinformed and led to believe false economic doctrines. When any considerable class is adversely affected, such for example, as the wheat growers or the coal consumers, what is the first suggestion for relief? 'Take it out of the railroads.'

"In the Transportation Act of 1920, Congress placed the regulation of the railroads in the hands of the Interstate Commerce Commission with instructions to see that no injustice is done any shipper; it also charged them with the equally important duty of seeing that the railroads receive a return, that will attract capital sufficient for adequate growth and development. Mechanically, the railroads are on the way to handle the ever-increasing volume of traffic and to do it so much more economically as to give promise of ultimate freight rate reductions.

"Efforts are being made to repeal the Transportation Act or so to amend it that the revival of railroad credit will be impossible and public interest will suffer irreparable damage. The immediate objective of far-sighted citizens is, therefore, a further trial of the Transportation Act without experimental amendments.

"Can you not picture a shrinking map with the Missouri Valley products only forty-eight hours from Atlantic harbors? Can you not visualize, with the prosperity incident to these developments, an enormous increase in the use of mechanical equipment on the farm, in the home, on the railway, in the air—wherever there are tasks for human hands to perform? Does this not mean that the manufacture of machine tools will become a more stabilized industry depending less on the activities of any one line and more on the general prosperity of all the people?"

Mr. Kearney's complete address may be obtained by addressing the National Machine Tool Builders' Association, Provident Bank Bldg., Cincinnati, Ohio.

Mr. DuBrul's Report

In his comprehensive report, Mr. DuBrul referred to a great many subjects of special interest to the machine tool building industry. He dealt particularly with the state of the industry at the present time, the effect of business cycles, and the prospects ahead. He emphasized the necessity for studying the conditions of the market, and basing factory activities upon exact statistical information. He reviewed in detail the work of the association since the last meeting of the membership, and pointed out the services that a trade association can render its members.

During the summer, a special study of sales ratios has been made, from which some very interesting data have been compiled. The importance of such studies were emphasized. Mr. DuBrul pointed out that anyone who undertakes business must assume the risk of ignorant competition. He said, "It does no good to bewail ignorance. It can be removed only by education of the ignorant as to costs and good business principles, through legitimate association work. The man who will not work to educate his ignorant competitor is very illogical in complaining of the results of that ignorance. Cooperative study of the facts is necessary before the industry can combat the evils that it complains of. Those executives who know the bearing of these facts owe it to their own stockholders to join in such study, not only for their own information but also for the education of those who are not well informed."

Machine Tool Research

On the subject of machine tool research, Mr. DuBrul made the following remarks: "Since our last convention several research movements have started in connection with machine tools. Most notable of these is an appropriation of $10,000 per year, from the Michigan Manufacturers' Association, placed at the disposal of the University of Michigan for research on questions affecting machine tool design.

"The American Society of Mechanical Engineers has appointed a Sectional Committee to act as a clearing and steering committee on machine tool research. This committee hopes to make available all possible research already done in connection with machine tools. It also hopes to get in touch with all work now going on, so that unnecessary duplication shall be avoided. In addition to this clearing function, the committee will act as a steering committee to set out the main problems in the order of their importance to the industry, and to urge that these be taken up in advance of less fundamental things. A preliminary report will be presented to the Machine Shop Section of the American Society of Mechanical Engineers in December.

"Scientific research has so well demonstrated its value in other lines of business that the machine tool industry must take notice. In industries whose total product is less than a quarter of the value of the machine tool industry, associations profitably spend considerable sums on research work. All industries that do research work report that they get their money back over and over again. Is there reason to think that the machine tool industry would not profit by well planned work of the same kind?"

Importance of Statistics

Mr. DuBrul pointed out how comparatively cheaply statistics may be compiled when the method for collecting them has been systematized. He also mentioned that the Department of Commerce urges all industries to organize adequate statistical service.

"The days of secrecy in business," Mr. DuBrul said, "are largely over. With statistics and information a manufacturer can plan his own financing, sales and production schedules more accurately. With specific information in hand, it is possible to slow down production of sizes or types that sell slowly and speed up on the faster sellers. Production schedules can be revised when a wave of concellations is reported. No one will be misled in expanding his plant beyond reason because of a temporary spurt of orders."

Mr. DuBrul urged greater cooperation in collecting statistics that can be used as a guide by the entire membership.

New Officers for the Year

At the meeting the following new officers were elected for the coming year: President, Ralph E. Flanders, of the Jones & Lamson Machine Co., Springfield, Vt.; first vice-president, O. B. Iles, of the International Machine Tool Co., Indianapolis, Ind.; second vice-president, Frank N. MacLeod, of the Abrasive Machine Tool Co., Providence, R. I.; and treasurer, H. M. Lucas, of the Lucas Machine Tool Co., Cleveland, Ohio. The following new directors were also elected: Ralph E. Flanders; H. M. Lucas; J. G. Benedict, of the Landis Machine Co., Inc., Waynesboro, Pa.; and H. P. Dix, of the Wilmarth & Morman Co., Grand Rapids, Mich.

Metal Cleaning

By F. H. GUERNSEY, Chief Chemist, The Cowles Detergent Co., Inc., Lockport, N. Y.

METAL cleaning is performed after finishing operations because the metal surfaces must be freed from foreign substances before the part is assembled or before micrometer measurements are made or gages used for inspection purposes. Metallic surfaces must be chemically clean before plating to insure a metal-to-metal contact, and they should be thoroughly cleaned before painting and enameling operations, as oily films, grit, finger marks, and similar defects must be absent from the work if these operations are to be successful. In thorough metal cleaning, oils and greases must be emulsified or saponified, or both; solid dirt must be rinsed from the metal surfaces and suspended in the solution; and acids or other corrosive materials must be rendered harmless by neutralization. It is important that the cleaner itself must not leave any corrosive material on the metal.

There are many factors involved in effective metal cleaning, none of which can be neglected if satisfactory results are to be obtained. Among these are the condition of the water, type of equipment, temperature of the cleaner, and time allowed for cleaning.

Importance of Condition of Water

Unfortunately, in metal cleaning hard water is used almost exclusively. Water containing lime and magnesium is wasteful of cleaners, because the hardness prevents the cleaner from doing its work. The hardness is removed by the chemical action of the cleaner on the water, which results in the formation of salts that settle at the bottom of the solution. The amount of cleaner consumed in softening water is enormous, and this cannot be avoided except by the use of pre-treated water. When hard water comes into contact with soaps or fats, the reaction forms "lime soap," a sticky insoluble curd, which floats as a scum on the surface of the cleaning solution. Unless care is used, this will give trouble in taking the work from the tank.

Caustic is not efficient for softening permanent hardness; however, it plays a part indirectly by saponifying fats in the dirt. Precaution should always be taken to overcome the hardness by some cheap means other than by using soap, such as precipitation by alkaline salts. This is the important thing to remember if a cleaning tank is to be operated economically. Everyone using cleaners has probably had the experience of failing to get results from a solution immediately after it was prepared, and then suddenly getting satisfactory results. This is very likely due to the presence of calcium and magnesium in the water, which, until converted into an inert form, prevents the cleaner from doing its work. It will be obvious from the foregoing that hard water necessitates the use of a larger amount of cleaner than soft water.

Type of Equipment Used

Cleaning tanks should be provided with suitable devices for heating quickly. Steam pipes, arranged in the form of a vertical coil at the front of the tank, are preferable. This arrangement tends to drive the scum toward the rear, leaving a clear surface through which the cleaned work may be withdrawn. If an outlet or skimming pipe is connected to the tank at the surface of the solution, it should be equipped with a valve that can be closed to prevent the discharge of the solution when it boils or when large bulky parts are immersed. The addition of water to maintain the level of solution in a tank dilutes the cleaner, introduces hardness, and soon destroys the efficiency.

The continual agitation that some operators provide by means of air is equivalent to a violent steam boiling, and is very effective in the removal of insoluble particles from the work. Such equipment as hoists permits increased production by reducing the immersing and removing time, or allows a slightly longer period for the actual cleaning to take place.

An electric cleaner should not be installed until a careful investigation has been made to determine whether or not it will prove beneficial. This type of cleaner should never be applied when different kinds of metal are being cleaned in the same tank, as, for instance, copper and steel. All electric cleaning tanks should be well insulated to save current and to prevent electrolysis.

Generally speaking, the hotter the cleaning tanks, the more efficiently they operate. Solutions that are cold or lukewarm cause waste of time and give poor results. There are frequent cases where, owing to insufficient ventilation, there is a tendency to operate tanks at low temperatures, but imperfect cleaning invariably results. Air agitation of the solution is advisable under such circumstances as an aid to action. For heating the tank, a closed steam coil is preferable to an open steam jet. When air agitation is not employed, the temperature should range from about 180 to 200 degrees F.

Where the cleaning of work involves both chemical and physical action, owing to the character of the foreign matter to be removed, more time must necessarily be given to the operation than where it is only necessary to remove light oil and dirt. In jobs of the latter sort, parts might need to remain in the solution for a short wetting only, whereas when both chemical and physical action are necessary, several hours may be required.

How Different Metals are Affected by Cleaning

The kind of metal to be cleaned is also an important factor in the success of the operation. A strong solution of cleaner may be too corrosive and cause the surface to be etched or tarnished. In cleaning zinc, aluminum, tin, Brittannia metal, etc., there is a tendency toward oxidation whenever alkaline cleaners of the usual type are employed, and as a result manufacturers handling these metals have frequently found it necessary to use benzine. Recently a cleaner has been discovered in which the action of the alkali is so controlled that the surface of metals of the class mentioned is not corroded to any perceptible extent. Aluminum, for instance, has been boiled in this cleaner without corrosion or etching, and in cleaning polished brass, which caustice soda and soda ash have a tendency to tarnish, the parts may be left in the solution all night without tarnishing.

In cleaning steel, it is customary to use an acid or pickling solution in connection with the alkaline cleaner, so as to remove any tarnish or rust which may hold oil under its surface and also any scale that may be present. This is important because there are certain conditions under which scale will absorb oil. If the surface oil is properly removed, the acid will penetrate the scale, and when it is removed the scale-bound oil also floats off. However, it is essential that the surface oil be entirely removed first, as otherwise the acid cannot wet the scale.

Oils on Metal Parts

Oils found on parts in the metal-working industry are practically of two kinds; one is the straight mineral

oil and the other is a mixture of mineral oil and the so-called "sulphonated" or cutting oil. The second oil is saponifiable. Straight mineral oils are by far the most difficult to remove from parts, and necessitate some "surface-tension-lowering" material in the cleaner solution for the purpose of emulsifying the oil. The material mostly used for this purpose is soap, and the successful cleaning of parts covered with mineral oils cannot be accomplished without its use. Cleaners that are efficient emulsifiers derive their properties in this respect from the soap in them.

The function of sulphonated oils, when mixed with mineral oils, is to emulsify the latter or, in other words, to break up the oil into fine globules that mix with water. This same object is accomplished by the soap used in cleaner solutions for removing straight mineral oil. Therefore, in those cases where a sulphonated or soluble oil is involved, little or no soap may be required, because soluble oils are derived from vegetable oils so that there is frequently a small amount of fatty acid present. The fats combine with the alkali to form soap, and this soap, in turn, is an aid to emulsification.

When to Use an Electric Cleaner

When large production is involved, the electric cleaner system has advantages under certain conditions. One should appreciate, however, that the initial cost of the equipment is high, and unless already provided with an ample supply of low-voltage (about 6-volt) direct current, the installation cost will considerably exceed that of the usual hot cleaner installation. A current density of about 35 amperes per square foot of surface to be cleaned is necessary, and, assuming that the cleaning may be accomplished in ten minutes, the energy required will be 35 watt-hours per square foot of surface cleaned.

The success of either the electric cleaner or the hand scrubbing methods depends largely on the shape of the pieces. If there is much "filigree" or beaded surface, the hand scrubbing method may give better though slower results. On the other hand, if the accumulation of dirt, grease, or buffing compound does not amount to much, the electric cleaner will give satisfactory results. Since heavy grease exerts an insulating effect on the surface of the metal, the current will not pass through at those points covered with grease, and the boosting action of the gas evolved from the work in the electric cleaner system is needed. A hot water rinse is recommended after electric cleaning, then a pickling bath in either muriatic or sulphuric acid containing some hydrofluoric acid to remove silicious scale, and then a cold water rinse. If the part is to be plated, this should be done next. The manufacturer must determine for himself from labor costs and the nature of the work whether the hot or the electric cleaning method will give the lower unit cost. If quantity production is desired and the work is not too dirty, the electric cleaner will prove the cheaper to operate.

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S. A. E. PRODUCTION MEETING

The Society of Automotive Engineers held its second annual production meeting in Cleveland, October 25 to 27. A great number of papers, as referred to in October MACHINERY, were read at this meeting, but it is not possible at this writing to review in detail all these papers, because at the moment that MACHINERY goes to press, they have not yet been released for publication. Those interested, however, will be able to obtain complete copies from the Society of Automotive Engineers, 29 W. 39th St., New York City.

A few of the papers are briefly abstracted in the following paragraphs: A. F. Shore, president of the Shore Instrument & Mfg. Co., Jamaica, N. Y., read a paper on the "Standardization of Methods of Applying the Scleroscope." In this paper Mr. Shore called attention to the nine items suggested by the Iron and Steel Division of the Society of Automotive Engineers for consideration with reference to obtaining greater uniformity in practice when making precision hardness tests with the scleroscope. These nine items are as follows:

1. Plumbness of the instrument at the time of hammer-drop.
2. Effect of lateral vibrations or shocks on the hammer.
3. Smoothness of surface of the test specimen.
4. Condition of the diamond in the hammer.
5. Effect of mass on the test specimen.
6. Thickness of the test specimen.
7. Effect of testing near the edge of the test specimen.
8. Effect of curved surfaces of test specimens.
9. How test-specimens are held or mounted.

A comparison between the Brinell and the scleroscope hardness testing method was also made.

A paper on "Factors Governing 'Out-of-roundness' Measurements" was read by A. H. Frauenthal, chief inspector of the Chandler Motor Car Co., Cleveland, Ohio. In this paper the author states that an out-of-round surface having an even number of high spots requires a checking instrument that has opposed measuring points; and that, if the number of high spots on the surface is uneven, an instrument having three-point contact, with one of the points of contact located on the center line between the other two, is necessary. Concerning the use of the three-point method for close work, the angle between the three points of contact must be selected according to the number of high spots.

"Spur Gear Grinding and Testing" was the subject of a paper presented by A. J. Ott and C. L. Ott, president and secretary-treasurer, respectively, of the American Grinder Co., Detroit, Mich. This paper dealt with the gear tooth grinding machine illustrated and described in the present number of MACHINERY, page 225. It also described the machine for testing gears, which was described in September MACHINERY, page 74. The paper dealt both with the principles of gear grinding and testing by means of the machines illustrated, and with the constructional features of the machines.

"The Application of Conveyor Equipment to a Small Production Plant" was dealt with in a paper by H. P. Harrison, master mechanic of the H. H. Franklin Mfg. Co., Syracuse, N. Y. In considering the problem of installing conveyor equipment at the Franklin plant, the following important requirements had to be met:

1. An elastic schedule of from 20 to 60 cars per day.
2. A minimum amount of plant rearrangement.
3. An investment commensurate with the saving to be effected.
4. Ability to make the installation without interrupting production.

In the course of the paper, it was pointed out that for the average plant of comparatively small production it is not practicable to use power-driven conveyors when the operations are not performed directly on the conveyor lines. The author dealt with his subject under four different heads: (1) Raw-stock handling conveyors; (2) conveyors for machining operations; (3) conveyors for sub-assemblies; and (4) conveyors for finished assemblies.

"The Human Element in Production" was dealt with in a paper by W. F. Jameson, chief inspector of the Cleveland Automobile Co., Cleveland, Ohio. Mr. Jameson pointed out that in many establishments the possibilities of training the mind behind the man has been overlooked. The management often thinks of workmen as so many hired hands, and appears to expect nothing from the men but the work of their hands. In too many cases this attitude is accepted by the men, with the result that they give nothing more. "Motion pictures have been made," says the author, "of the action and motion of hands, and remarkable results have been accomplished in that way from a production standpoint." But he believes that there are still greater results to be obtained by cultivating more than the machine side of the workmen. "It cannot be denied," says Mr. Jameson, "that the man who takes an interest in his job and applies himself to it will turn out better work with fewer mistakes, and that his output will also be larger."

American Gear Manufacturers' Convention

THE semi-annual convention of the American Gear Manufacturers' Association was held at Lake Mohonk, October 25 to 27. This was the first convention held under the leadership of the new president, George L. Markland, Jr., of the Philadelphia Gear Works. In a brief address of welcome, President Markland sounded a characteristic note of "smiling optimism," with due recognition of the necessity for caution in business ventures. He commended the association particularly for its splendid work on standardization, and characterized these noteworthy achievements as "an engineering work, which, when properly and correctly done, stands as a monument to those men who devote their time to it." The acceptance by great engineering bodies of five A. G. M. A. standards during the short life of the association was referred to as concrete proof of the practical work already done, and credit was given to the former president and present honorary president, F. W. Sinram, together with B. F. Waterman, chairman of the General Standardization Committee, and the chairmen of the various other committees.

Papers Presented to the Convention

Papers or addresses on a variety of subjects of interest and value to the gear industry were presented. Major Earle Buckingham, of the Niles-Bement-Pond Co., dealt with an analysis of milled gears, as produced by formed cutters. Since cutters of this type are correct only for a certain number of teeth, one purpose of this paper was to analyze the nature and amount of such errors. Another purpose was to show how a cutter of a different number than listed for the tooth number required, might be used with as good or better results by a slight modification of the depth of cut. Still another object was to determine the amount of excess depth conducive to the best results in cases where the depth is increased to provide more backlash than is present when gears are cut to the theoretical depth.

John P. Kottcamp, head of the Department of Industrial Engineering at Pratt Institute, Brooklyn, N. Y., presented a paper on the training of shop executives. Possible solutions of the following vital problems were offered: (1) How and where shall the men in industry receive the special training that is so essential to advancement? Shall it be in the shop under instructors who are a part of the organization, or shall it be given outside in schools whose chief aim is the training of this type of men? (2) What are the special inducements that would make men desire this technical training? (3) How shall these technically trained men be fitted into the organization without causing friction between the trained and the untrained men?

It was pointed out that there is an increasing demand on the part of industry for men who have been definitely trained to function eventually as successful executives, although, unfortunately, the typical engineering college is not fully meeting this demand. The opinion was expressed that in many cases it is best for young men, on graduation from high school, to have one or two years of practical work, on the assumption that this will give each man a chance to find himself.

According to Mr. Kottcamp, success of the school or organization that undertakes the training of men for positions of leadership depends upon selecting the men that meet the specifications which can be given only by those experienced in such training. It was also emphasized that back of all successful technical training must first be the development of character, and second in importance to character development is the thorough mastering of fundamental principles of whatever subjects are being studied. In closing, it was emphasized that industry must share this burden in assisting high-grade technical schools to function properly by keeping them posted on the latest developments, and by supplying the men for training who are capable of making full use of the training.

Research Work in the Industry

"Development of the Gear Industry" was the subject covered by E. W. Miller of the Fellows Gear Shaper Co. The primary object of this address was to emphasize the advisability and probable necessity of a painstaking inspection of all factors influencing the gear industry. While the value of the association in developing standards, as well as refined gear-cutting and gear-testing apparatus, is fully recognized and appreciated, it was pointed out that the promotion of the industry represents another important task which should receive the attention of the A. G. M. A. "It is uncommon," said Mr. Miller, "to find in a mechanical institution a department whose purpose is business research engineering. The office of such a department would not only be to explore the present gear field with painstaking determination, but to ascertain accurately to what new uses gears may be put, thus bringing out the potential possibilities. . . . We should, to the full limit of our resources, get into new design work, and then, without presumption, but with a sincere desire to solve the problem for the best interests of all concerned, offer our best engineering advice." By way of suggesting development possibilities, a number of special gear applications were presented.

An address was made by R. M. Hudson, of the Division of Simplified Practice, Chamber of Commerce of the United States, on "Simplified Practice as a Service to American Industry." At the informal dinner S. L. Nicholson, of the Westinghouse Electric & Mfg. Co., spoke on business conditions in the Far East.

Work of the Standardization Committees

The following summary of the work of the standardization committees, under the chairmanship of B. F. Waterman, indicates not only the activity of these committees, but also the practical nature of their work. There are sixteen committees on technical standardization, although it is not possible at this writing to summarize all the reports.

The Spur Gear and Nomenclature Committees presented recommendations on which definite action will be taken at the spring meeting. The Worm Gear Committee made a definite recommendation, the object of which is to reduce the number of worm hobs now carried in stock by various member companies. It is well know that there are a great many hobs in use, although most requirements would be met if the number were greatly reduced. The committee's report not only recommends new designs, but also includes recommendations applicable to existing hobs.

The Bevel Gear Committee made recommendations in regard to bevel gear nomenclature and submitted a "graphic picturization" of the terms used and defined. This should be of value to the entire industry, as it makes clear without words just what each definition means. The Sprocket Wheel Committee made a definite recommendation for standards for transmission chains and sprockets. This recommendation is the same as that submitted by the joint committee of the Society of Automotive Engineers, the American Society of Mechanical Engineers, and the American Gear Manufacturers' Association, which was made public in *Mechanical Engineering*, August, 1923. This is regarded as an outstanding piece of work that should help every user of roller chains.

The Composition Gearing Committee offered as a standard a revision of the original composition gearing standard, which was first adopted in October, 1919. The revision eliminates much of the matter explaining how to use the tables, the latter having been made self-explanatory. This standard was approved by the Sectional Committee; it will be submitted later to the sponsor societies for their approval, and still later to the American Engineering Standards Committee, provided the approval of the sponsors is obtained.

The Keyway Committee offered a definite recommendation upon which no action was taken. This committee has been working in conjunction with the American Society of Mechanical Engineers, and will continue to do so until a standard agreeable to both manufacturer and user is obtained. The Tooth Form Committee made definite recommendations along some lines and tentative ones along others, and it is probable that these recommendations will provide a basis for definite work during the coming winter. The Library Committee made a recommendation in its progress report regarding the publication from time to time of tables in loose-leaf form, which can be filed away in some standard loose-leaf binder in order to produce eventually an authoritative gear manual.

The Inspection Committee made a progress report. This committee now has in mind recommendations as to a method for testing certain types of cutters, and the subject of raw material inspection has also been considered in conjunction with the Metallurgical Committee. The latter committee, which in the past has been very active, found it necessary for good reasons to make a progress report only, although it has under way recommendations that should prove of great value to manufacturers and users of gears. Progress reports were also made by the Herringbone Gear Committee, the Committee on Electric Railway and Mine Gears, the Differential Committee, and the Transmission Committee.

Since January, the Sectional Committee on standardization, which is composed largely of members of the two sponsor societies, namely, the American Society of Mechanical Engineers and the American Gear Manufacturers' Association, has held two meetings—one last January and one in September. The nomenclature of gears was considered at both these meetings, and some sixty definitions have been approved and will soon be submitted to the technical press. The Sectional Committee on standardization will consider at its next meeting tentative standards for stub tooth gearing submitted by the French and Dutch engineering societies. It appears that the question of a stub tooth standard is of interest at this time to the users of gears all over the world, and in the near future it is believed that a recommendation can be made which will be the basis of a future standard. The Sectional Committee on standardization has been recently enlarged to include representatives from other societies, and the work of this committee is receiving more and more attention from users of gears.

* * *

OFFICERS OF THE A. S. M. E. FOR 1924

The results of the election of officers of the American Society of Mechanical Engineers for 1924 have been announced. Fred. R. Low, for more than thirty-five years editor of *Power*, New York City, has been elected president. Three vice-presidents were elected: George I. Rockwood, president and treasurer, Rockwood Sprinkler Co., Worcester, Mass.; W. J. Sando, consulting engineer, Milwaukee, Wis.; and H. Birchard Taylor, vice-president, Wm. Cramp & Sons Ship & Engine Building Co., Philadelphia, Pa. The following three managers were elected: E. O. Eastwood, professor of mechanical engineering, University of Washington, Seattle, Wash.; F. A. Scott, president, the Warner & Swasey Co., Cleveland, Ohio; and E. R. Fish, vice-president, the Heine Boiler Co., St. Louis, Mo. W. H. Wiley, president of John Wiley & Sons, Inc., New York City, was re-elected treasurer.

ENGINEERING EDUCATION AND ITS RELATION TO INDUSTRY

The National Industrial Conference Board, 10 E. 39th St., New York City, has issued Special Report No. 25, dealing with engineering education and American industry. This report deals with the need for trained leadership in industry, and the educational problems connected therewith. It outlines the present requirements in the industries and specifies the kinds of engineering talent needed. It covers the educational problems in a comprehensive manner, and should prove of interest both to employers and men engaged in teaching engineering.

The report may be summarized as follows:

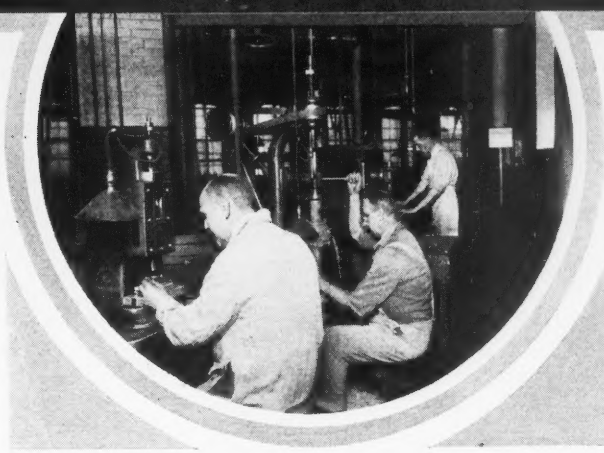
1. There is a rapidly growing need for administrative and technical ability in practically all lines of activity. This is especially true of the manufacturing and mechanical industries.
2. There is an increasing demand for graduates of engineering schools to enter upon work which will fit them for positions of administrative as well as technical responsibility. This, apparently, is because courses of education in engineering and applied sciences have been highly successful in the early development of both kinds of talent.
3. The demand for young men with capacity for becoming administrative or technical leaders is already far greater than the number of such men now being graduated from the engineering schools.
4. It is, nevertheless, more important that a greater proportion of the graduates of engineering schools be young men of high quality than that the total number of graduates be increased. Therefore, admission to these schools should be based on selective tests for fitness, intelligence, and character, as well as knowledge.
5. The preparatory schools can perform a great service to industry, as well as to the students, by properly evaluating the advantages of the engineering schools and guiding toward those schools the boys who have, or in whom can be developed, an interest in producing things. Such boys should develop into industrialists.
6. There is a growing opinion that the engineering schools should provide a thorough grounding in fundamentals of engineering and applied sciences, rather than specialized training. Such a grounding is best accomplished when accompanied by actual contact with industry as well as by work in classroom and laboratory.
7. There should be more and better training courses in connection with industrial establishments to supplement the educational courses of the colleges.
8. Close coordination of educational effort is therefore necessary between industrialists and educators to meet the need for leaders.

* * *

GAS MANUFACTURERS TO COOPERATE WITH WELDING SCHOOLS

The Gas Products Association, 140 S. Dearborn St., Chicago, Ill., has appointed an educational committee to cooperate with trade and technical schools all over the country in supplying a practical and standard course in welding procedure. The users of oxy-acetylene welding equipment have never been thoroughly satisfied with the work done by welding school graduates, and at the same time, the application for welding processes has been extended to so many new fields that the demand for skilled operators is constantly increasing. It is thought that by making a thorough investigation of the needs of the industry and then making recommendations to welding school instructors, the instruction programs can be standardized so as to meet more fully the requirements of employers. The plan has been submitted to some schools and has met with their approval. The committee will endeavor to build up a list of accredited schools which are known to give a standard instruction and whose students can be depended upon to qualify as satisfactory welding operators. It is proposed to make this movement effective all over the country.

An Example of Systematized Production



Arrangement of Equipment Used in Producing a Predetermined Quantity of Work in a Given Time

By FRED R. DANIELS

IN the manufacture of gasoline-savers used in connection with Ford carburetors, an arrangement of the machine shop equipment that has resulted in a high rate of production has been adopted by the Taft-Peirce Mfg. Co., Woonsocket, R. I. This arrangement, which is shown in Fig. 1, insures that all the space available is occupied to the best advantage, and it enables a daily production of 500 of these gasoline-savers (see sectional view, Fig. 2) to be obtained.

On one side of the bay there is a bench with the usual equipment, as well as the desk of the inspector. The machines are located in such a way that a steady flow of work passes from the left to the right. Liberal truck space is provided between the rows of machines, so that a line of trucks may be passed between them to deliver the work from machine to machine. The machine equipment includes two Brown & Sharpe universal milling machines with vertical heads; two Leland-Gifford drilling machines, each having a two-spindle Nelson-Blanck drill head; one No. 0 Brown & Sharpe screw machine; one Bosworth foot press; three No. 2 Brown & Sharpe screw machines; four Dwight-Slate seven-spindle drilling machines; one Dwight-Slate marking machine; and one Prentice lathe.

The gasoline-saver unit consists of a bronze body in which a jet *A*, Fig. 2, and a mixing tube *B* are assembled, and a brass piston *C* with a tubular rod or stem seating on the mixing tube when the coil spring within the piston-head is compressed. These bronze castings are machined to limit-gage dimensions, and the accuracy required for such parts as the alignment and fit of the piston-rod and mixing tube is exceedingly close. Every important operation must be inspected on the floor during the process, and for this work an inspector is employed who moves from machine to machine. No operation is continued that does not pass this inspection.

The machine equipment includes not only that required for the various machining operations on the body casting, but also for operations on the jet and piston-head. The tubular parts are not machined. Equipment other than that used in machining the body includes one small power press, two small screw machines, one tool grinder, and bench equipment consisting of vises, a bench tool grinder, an arbor press, and a surface plate for the inspector.

The bronze castings are first slab-milled on both sides. For this operation, two universal milling machines are employed, arranged to face each other, as indicated by the numerals 1 in Fig. 1. The machines are equipped with vertical heads and fixtures that accommodate two castings at a time as illustrated in Fig. 3. An end-mill 2 7/8 inches in diameter is passed once across the two castings, and the arrangement is such that at every pass of the cutter, one casting is milled on both sides; that is, a fresh casting is placed in the fixture with one that has already been milled on one side. An eccentric cam clamps the two castings at one movement of the lever, the jaws being formed to fit around the outline of the castings. The tolerance on the thickness is 0.010 inch.

Drilling the Attachment Holes

The work is then placed on a truck that stands between the two milling machines in close proximity to the drilling machines on which the next operation is performed. This permits the operators to take the work from the truck, drill it, and pass it on to another truck. This gen-

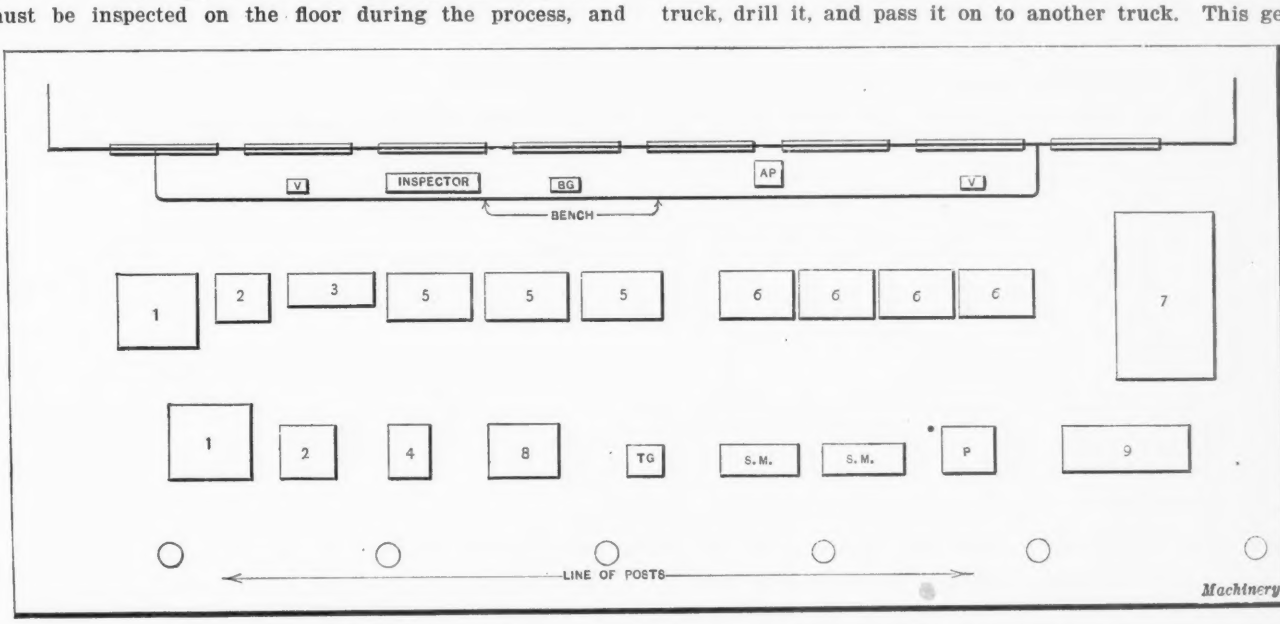


Fig. 1. Lay-out of Machine Equipment in the Department where Gasoline-savers for Ford Carburetors are made

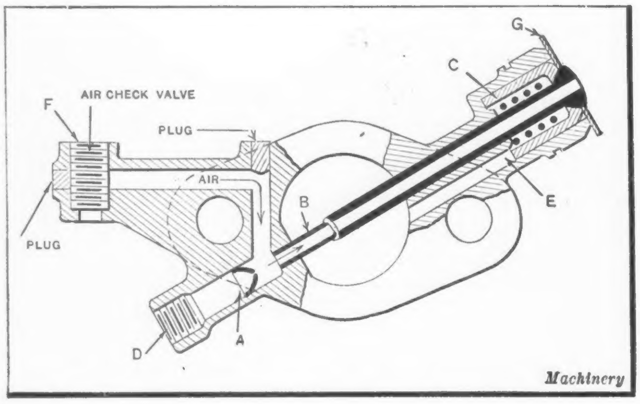


Fig. 2. Section of a Gasoline-saver for Use on Ford Carburetors

eral procedure is followed throughout the entire sequence of operations.

The two upright drilling machines, numbered 2 in the diagram, Fig. 1, are furnished with two-spindle drill heads, for drilling the large holes by means of which the gasoline-saver is attached to the carburetor (see Fig. 2). These holes are 13/32 inch in diameter, and while being machined, the work is held in a special fixture supported by two spring fingers which rest on spring plungers machined with a notch in the end to form a cradle for the work.

Squaring off the Side of the Cored Hole

After both sides of the holes have been countersunk slightly on a hand screw machine equipped with a combination pilot countersink, the castings pass from machine No. 3 to the Bosworth foot press, indicated by the number 4 in Fig. 1. The operation performed here is a simple one, but is is necessary to facilitate the hand screw machine work, which immediately follows. The press is equipped with a simple die and a broaching tool for squaring off the side of the cored hole through which the mixing tube hole is subsequently machined.

Hand Screw Machine Operations

From the foot press, which is the machine shown in the foreground in the heading illustration, the trucks are wheeled along to the three screw machines indicated by the numeral 5 in the diagram. A close-up view taken from the rear of one of these machines is shown in Fig. 5. The work is clamped flat, with the center line of the piston in line with the center line of the machine, and is located on an angle-plate fixture, attached to the spindle of the machine. This fixture and the quick clamping arrangement for holding the work are shown at *A*. The casting is prevented from moving by two dowel-pins fitting into the previously drilled holes.

In the illustration the fourth station tool is shown in the operative position. At the first station, indicated at *B*, a box-tool is used that carries two cutters, one of which chamfers the end of the casting in which the piston-head fits, while the other rough-turns the four lugs over which the cap is assembled. (The lugs are shown in Fig. 7.) These two tools operate at the same time that the piston-head hole is being rough-drilled. The end of the drill is shown extending from the box-tool.

At the second station, the piston-rod hole, which is 3/16 inch in diameter, is drilled, the end rough-faced, and a special necking tool used to cut the 1/16-inch groove by means of which the cap is locked on. The necking tool and the rough-facing tool are mounted in an arm which is swung down to feed the tools in radially, as required, by the handle shown extending vertically upward. This arm is operated against spring tension, so that when the necking and facing have been finished and the handle released, the tools will recede from the cut. These two cuts are taken as soon as the 3/16-inch drill, shown directly beneath this special head at *C*, has completed the piston-rod hole.

At the third turret station a combination end-mill and reamer *D* is used in the second roughing operation on the piston-head hole, the nominal diameter of which is ⅝ inch. At the same time the outside diameter is finish-turned and the end finish-faced to length, both tools being carried in the arm extending on the opposite side of the tool *D*. This type of tool is the same as that used at the first station, and its construction insures a correct relation between the finished diameter of the piston-head hole and the outside diameter over which the cap fits. Next in the sequence of operations is the finish-reaming of the piston-rod hole and the semi-finish-reaming of the piston-head hole to 0.622 inch diameter. For this operation a combination reamer is employed to insure concentricity of the two holes—an essential condition to the efficient operation of the device. The finish-reaming of this ⅝-inch hole is not done on this machine.

The fifth and sixth turret stations carry a drill and reamer, respectively, for machining a hole 5/32 inch in diameter and 9/32 inch deep, in which the mixing tube *B*, Fig. 2, is a force fit. This hole must align perfectly with the piston-rod, so the drill used has a straight shank of the same diameter as the piston-rod, with a short 5/32-inch reamer-drill brazed in the end. The shank serves as a pilot in the piston-stem hole. After this, the operator may find it advantageous to swing the turret around again to the second position, and permit the necking tool to re-enter the groove to clean out any burrs that may have been formed in finish-turning the lugs on the outside diameter.

Arrangement of Drilling Machines

There are a number of holes to be drilled, reamed, counterbored, or tapped, as will be seen from the sectional view Fig. 2, and all of these operations are performed on a battery of four seven-spindle drilling machines. This row of machines is designated as No. 6 in the department lay-out shown in Fig. 1. A close-up view of one of these machines is shown in Fig. 4. The first, fourth, and seventh spindles of each of these machines are the only ones used, the space between these being occupied by three fixtures (such as are shown in the illustration) which are bolted to the table of the machine so that they are in permanent alignment with the spindles.

In every case, the castings are located in these fixtures from the two large holes previously drilled, and the locating buttons are simply changed as required for different positions. In connection with this simple feature, the clamping lever has a floating clamp which can accommodate itself to the various positions in which the work is held. No other

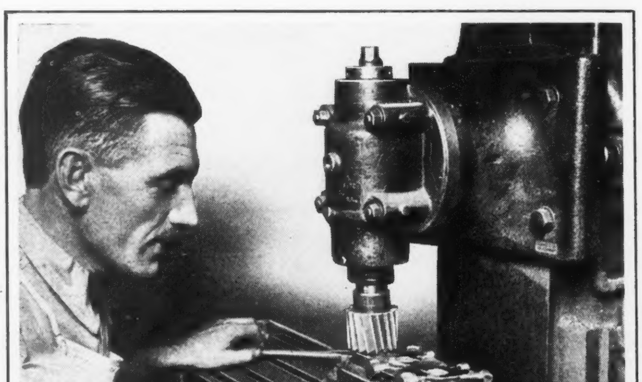


Fig. 3. Slab-milling Both Sides of the Casting

change in the fixture is required to make its application general on this work. The clamping lever handle has a toggle joint, and a cam on the end of the handle delivers enough clamping pressure to hold the work without much exertion on the part of the operator. This illustration also shows the compressed air tubes which are installed on every machine where dry chips are produced, for cleaning the work-holding element.

On this machine, the operations are as follows: Hole *D*, Fig. 2, is drilled, following which the gas chamber hole leading to the jet *A* is drilled and reamed. The 1/8-inch air hole *E* is the next hole to be machined, and then the counterbored hole for the air check-valve, the tap size drill used for this operation being an ordinary twist drill ground flat on the point to produce a square bottom. This gives good results on a bronze of the composition used. The surface *F* of the boss through which this air check-valve operates is next faced and countersunk with a combination tool, and then the two holes (shown plugged in the illustration) are drilled. Finally, hole *D* is tapped with a Briggs pipe thread to fit the connection to the carburetor; also the air check-valve hole is tapped for a 3/8-inch thread.

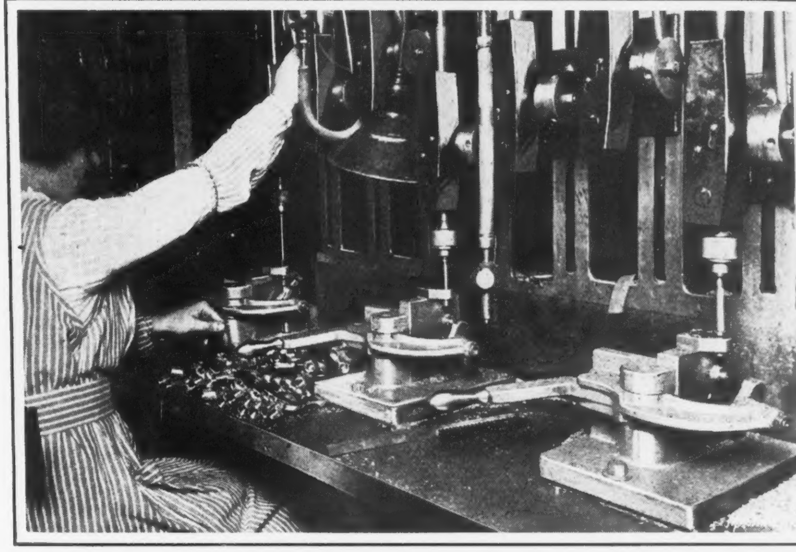


Fig. 4. Universal Drilling Fixtures used on Seven-spindle Drilling Machines

Final Operations on Body

The castings next go to the bench numbered 7 in Fig. 1, where the hand finishing operations of burring and filing are performed before the work is delivered to the final inspecting department. In the final inspection, a complete line of limit gages is used and the work is given a very rigid inspection. It is then returned to the bench and the two holes plugged (Fig. 2) to close the air passage from the air check-valve to the mixing chamber. The plugs are small brass screw machine parts with a slightly beveled end, and are somewhat difficult to handle. To facilitate this operation, an angle-iron is used on the table, on which the casting is held by two dowel-pins, so that the holes are in a vertical position according to which side of the angle-plate is used as a base.

The small plugs are picked up by a flat piece of ribbon stock which has a slot in the end that runs into a hole. This simple improvised holder is pressed on the beveled end of the plug, and the tension provided by the slot permits the hole to spring so as to encompass the plug. The plug can then be readily held while driving it in.

The buffing equipment is not contained in this department, so that after the holes are plugged, the work is delivered to the polishing room and buffed, and then returned to the department, where it is marked with the patentee's firm name, by a Dwight-Slate marking machine, located as indicated at 8 in Fig. 1. The nickel-plating is also performed in the regular plating department, after which the finish-reaming of the piston-hole is performed.

From the plating department the work is transferred to the machine indicated at 9, which is a lathe equipped with a combination 5/8- and 3/16-inch diameter solid finish reamer. The work is held in the hand while reaming. The finished hole is inspected with a limit plug gage that holds each diameter to a tolerance of 0.0005 inch. The concentricity of these two holes is also of great importance. This operation is purposely deferred until after nickel-plating, so that if any nickel has entered the hole, it will be cleaned out in reaming.

Machine Work on Jet and Piston

As stated previously, the machine equipment in this department is used to perform whatever machining operations are necessary on the jet *A*, Fig. 2, and the piston-head *C*. Both of these parts are brass shells drawn in a power press and purchased from an outside concern. A power press *P*, Fig. 1, is used to size the jets, which was found necessary on account of the variation in their outside diameter. The operation is simply that of pushing the jets through a sizing die.

The two small hand screw machines next to this sizing press are the last two machines to which reference is to be made. One of these is used to drill the jet hole through which the mixture of air and gas passes to the mixing tube. The other machine, illustrated in Fig. 6, is employed in turning and grooving the piston-head. The brass shell is held on an expanding chuck, consisting of a split collar *A* which is expanded by drawing in the rod that extends through the spindle. The end of this rod has a back taper. The collar has a driving lug which fits in a notch in the spindle nose.

The collar has an independent movement on the rod that is provided for by a pin in the collar engaging an elongated slot in the rod. The purpose of this is to permit the work to be freed from the chuck

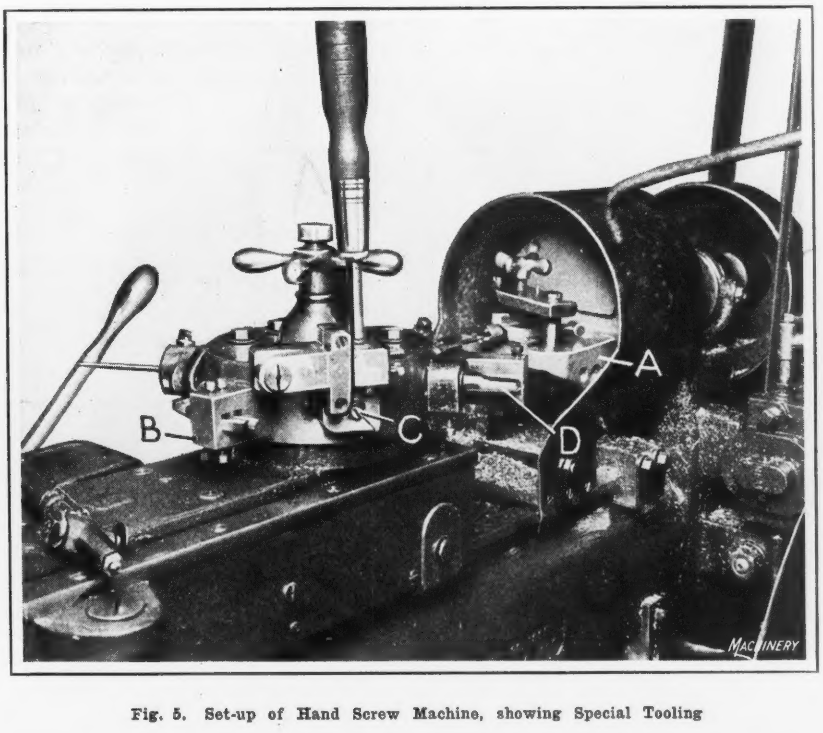


Fig. 5. Set-up of Hand Screw Machine, showing Special Tooling

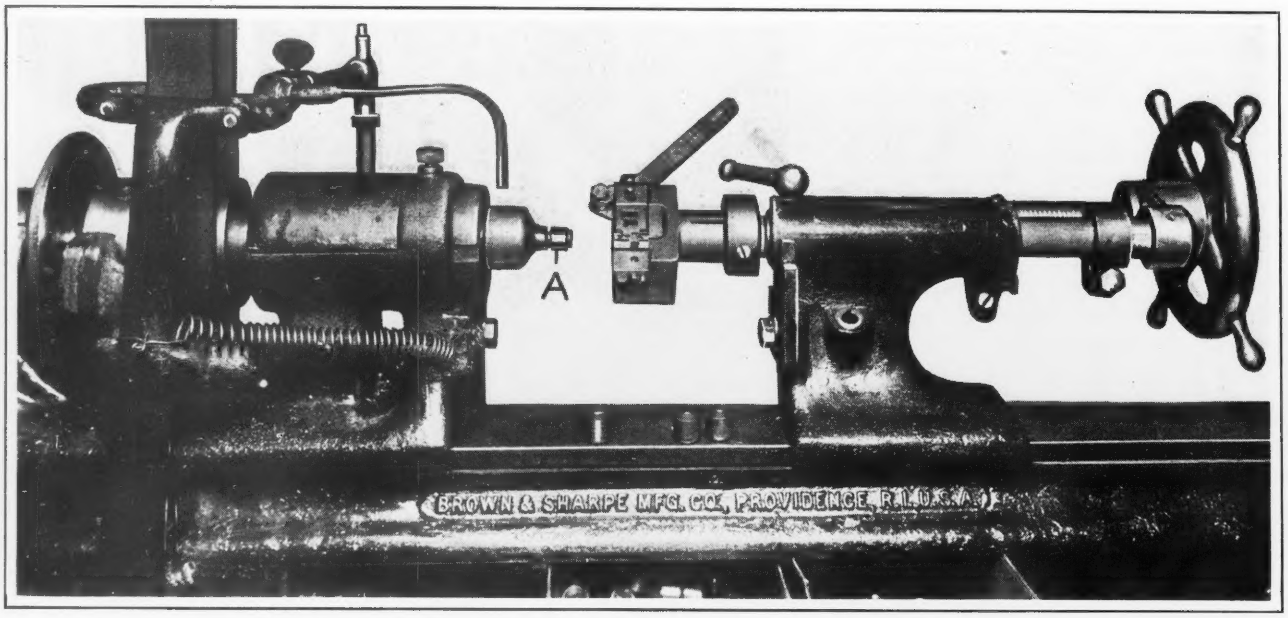


Fig. 6. Screw Machine equipped for turning and grooving Brass Pistons

by hitting it on the end to drive the collar from the taper and allow it to contract. That is the position of the collar shown in the illustration. A finished head and two unfinished ones are shown lying on the way of the machine. The box-type tool used carries a multiple grooving tool at the rear, which is operated by the hand-lever shown, after the turning tool has finished its cut. Beside the turning tool, there is another tool which serves as a front rest to take the thrust during the grooving operation.

The regular lever-operated tailstock has been changed over to be operated by a pilot wheel and screw so that a steady, even feed movement is delivered to the tool as it is advanced. This change was deemed advisable on account of the difficulty formerly experienced in turning the pistons to the extremely close limit and parallelism required.

Gages Used in Inspecting the Gasoline-saver

The care with which the gasoline-saver body and piston must be machined to meet the requirements of service will be appreciated by an enumeration of the gages used. For the lugs on the outside diameter of the cylinder there is a limit snap gage; for the diameter of the necking in the cylinder, a similar snap gage; for the cylinder bore, a "Go" and "Not Go" plug gage for both the semi-finished and the finished sizes for the depth of bore, a limit plug gage with the limits indicated thereon by flats milled on the sides, and an alignment plug for the diameter (0.625 inch) and the piston-stem hole (0.1875 inch). On the body, a limit snap gage is used for the thickness, a "Go" and a "Not Go" plug gage for the two attachment holes, and a length gage with limits of ± 0.003 inch, for the over-all length from the piston end to the end where the connection is made to the carburetor.

There is a limit plug gage for the mixing tube hole; an alignment plug for this hole and the piston-stem hole; a limit plug gage for the jet hole (0.250 inch); and a flush-pin gage for the depth of this hole. Flush-pin gages are also used in the piston-stem hole to gage the setting of the jet and the setting of the mixing tube, both of which have limits of ± 0.003 inch. For the tapped holes, a Briggs pipe thread gage is used for hole *D*, Fig. 2, and an alignment screw thread gage with a concentric plug for the air hole (0.1875 inch) through which the air check-valve stem projects. For checking the piston, a limit snap gage is used on the diameter, and a concentricity gage for the stem and head, these two parts being assembled by spinning.

Assembling Operations

While it is the purpose of this article to call attention mainly to the machining equipment and its use, a brief summary of the assembling operations will be given. The first assembling operation consists of forcing the jet and the mixture tube into place, and for this work the fixture illustrated in Fig. 7 is employed. The fixture has two rack- and pinion-operated arbors, on one of which a jet is placed at *A*, while a tube is fitted into a loose piece *B*, and

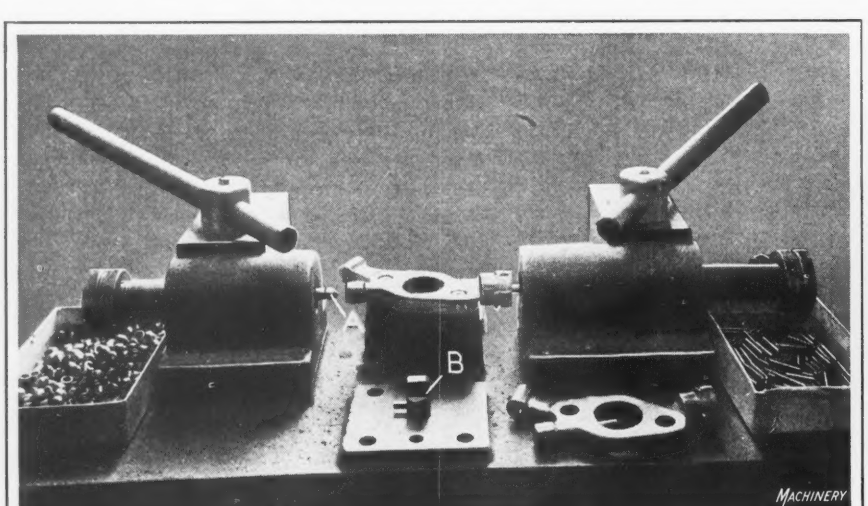


Fig. 7. Assembling Fixture for seating the Jet and Mixture Tube

Fig. 8. Foot Press for assembling Caps

this piece placed within the cored hole to align the tube with the center of the piston-rod and also with the center of the jet.

The other arbor simply pushes this tube through the holder and into the hole to a depth of about 9/32 inch. The two handles can be operated at once and adjustments made to seat each part in correct relation to the other. After this, the casting appears as shown on the base of the fixture. The air check-valve, which is a special headed screw with a weight through which the valve rod is adjusted, is then assembled, after which a filter screen is pressed into hole *D*, Fig. 2, and the nipple by means of which connection is made to the carburetor, screwed in place.

The piston is assembled to the piston-rod by spinning its end over, a leather gasket *G* being used between the piston-head and the spun end of the rod. When the piston is seated against the mixture tube *B*, this gasket seals the end. The spinning operation is performed on a Grant riveter, and the concentricity of the assembled parts is maintained by using a special holder for the rod so that the entire assembly can be held conveniently.

A brass coil spring is used in the assembly beneath the head, which must be of sufficient strength so that the piston will be drawn in and the joint between the piston-rod and the mixing tube sealed. Before this fitting of the spring is performed, which is an exceptionally tedious and delicate operation, the end of the piston-rod is countersunk to form a seat on the mixture tube. This operation is performed with a hand tool consistng of a master casting, carrying a steel countersink in place of the mixture tube *B*. This tool is set to a master gage, and is used by simply turning it back and forth with the piston held in place. The brass spring must be tested within the close limits of 2.9 and 3.1 ounces; that is, the piston gasket must barely seat when a 2.9-ounce weight is placed on it to compress the spring, and must seat firmly when a 3.1-ounce weight is used. The operation involves clipping the spring, until the desired length is obtained.

The last assembling operation is illustrated in Fig. 8. This is performed on a foot press, and consists of assembling the caps. The caps are slipped up into a holder, where they are held by a spring arrangement, and the gasoline-saver is located as shown in the illustration, by an angle-plate and two pins. There is a hand-lever on the front of the cap-holder, and after the cap has been forced down over the four lugs and has entered the neck or groove, it is given about a 1/8 turn by this hand-lever to lock it in place. Some of the caps are shown on the baseplate of the machine; the top is formed with notches, and these notches are employed by the holder to turn the cap.

Finally, there is a test for leakage around the seat of the mixing tube and piston stem and around the piston-head where the gasket closes the end. The device or instrument for conducting this test operates on the vacuum principle and in conjunction with a fluid gage, so connected to the casting itself that the location of any leak can be found. Even by using the utmost care in assembling the brass spring beneath the piston-head, some slight leakage may be shown to exist in this test, for it is the strength of the spring, of course, that primarily governs the leakage at these two points. In case leakage is discovered, another foot press is employed to remove the caps so that the spring can be corrected or changed.

* * *

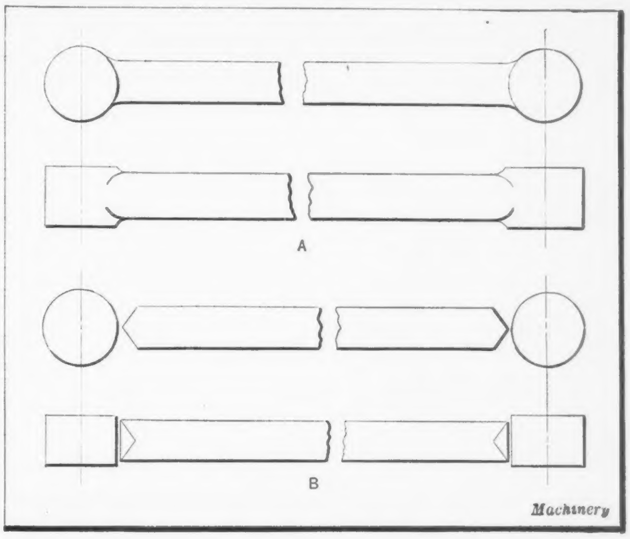
According to Louis W. Hill, chairman of the Great Northern Railroad, the cost of railroad equipment and service is from 70 to 125 per cent higher than ten years ago. The cost of a mile of track, exclusive of grading and right-of-way, has risen from $15,000 to $25,000. The average price of locomotives has increased from $24,000 to $54,000; of sleeping cars, from $16,000 to $36,000; of dining cars, from $14,000 to $31,500; and of coaches, from $9000 to $20,000. Box freight cars that used to cost only $800 apiece now cost as much as $1800.

REDUCING COST OF CONNECTING-RODS BY WELDING

By PAUL J. REES

Carefully worked out manufacturing methods are necessary when wrought-iron connecting-rods of various sizes are to be made in small lots, if the work is to be done neatly and economically. The concern with which the writer is connected requires a variety of rods of the type shown at *A* in the accompanying illustration. However, only a few rods of any particular size are required at a time. These rods vary from 1 to 3 inches in diameter and from 2 to 6 feet in length. The flat ends of the rods also vary in thickness. The thickness of the ends is the same as the diameter of the rod in some cases, and in others it may be as much as 2 inches greater.

The cost of dies for forging the stub ends for small quantities of rods on a forging machine was prohibitive, so the ends were hand-forged and then welded to the rod proper. This method was followed for a long time, but it was, of course, rather expensive. It was found that a cheaper as well as neater looking rod could be produced from three sawed off lengths of round bar iron, welded together.



Diagrams showing how Connecting-rod Parts are arranged for Welding

The two end pieces are sawed off to the exact thickness required and the flat sides clamped against a straightedge, with the connecting-rod properly located between them while welding, so that the ends are in proper alignment with the rod. This eliminates the necessity for facing the bosses, which had to be done in the case of the hand-forged rods. The ends of the connecting piece are pointed, as shown in the view at *B*, with the cutting torch or chipping hammer, in order to facilitate the welding operation.

The weld should be well filleted for strength, and when finished should be buffed smooth. This method of welding on the rod ends, either electrically or with a torch, produces a strong rod and a neat looking job that requires no machining other than the drilling of the ends for the pins. Rods thus made have proved satisfactory in every way, and a considerable saving is effected by this method.

* * *

Commercial Attaché H. Sorenson reports from Copenhagen, Denmark, that a Swedish engineer has developed a new type of speedometer which not only indicates but also records the speed of the car. The speedometer is provided with four sets of indicating figures: One set shows the maximum speed of the car during the last mile; another set the maximum speed during the next to the last mile; a third set of figures shows the distance covered from any given point when the indicator was set at zero; and finally the usual five figure register shows the total distance traveled by the car.

Dies for an Automobile Bearing Adapter

By JOHN A. HONEGGER

MANY small parts used in automobiles are made on punch presses. Two special dies developed for this class of work are described in the present article. The part produced is known as a bearing adapter, and is shown in the upper left-hand corner of Fig. 2. This part is designed to fit over a generator shaft and is blanked and drawn from 0.065-inch soft cold-rolled strips, 2½ inches wide by 36 inches long, sheared from large sheets.

First Operation on Bearing Adapter

The operations performed by the die shown assembled in the sectional view, Fig. 1, are: Pierce an 0.8125-inch center hole; pierce two ¼-inch pilot holes in the scrap stock; and form a flange around the center hole, as shown in the detail view of the work, Fig. 1. This die also blanks the pierced and drawn piece which is carried from the die by the scrap stock. Referring to the plan view of the die, in the upper left-hand corner of Fig. 1, the stock is fed in from the right-hand side until the edge strikes the beveled part *A* of the spring-actuated stock guide *B*, depressing this member sufficiently to allow the stock to pass on until it is stopped by the finger-stop *C*, which is pushed in by the left hand of the operator. A plan view of the punch is shown in the upper right-hand corner of Fig. 1.

On the first stroke of the press, the punches *D* and *E* held in punch-plate *F* perforate the 0.8125-inch hole and the two pilot holes in the scrap stock. The stock then passes over the spring-latch stop *G*. As the stock is fed forward, stop *G* drops into the 0.8125-inch hole. The stock is then pulled back against the stop which is held in position by the action of spring *H*.

On the second stroke of the press, the spring-actuated pilots *J* enter the pilot holes punched in the scrap part of the stock. The stock is thus properly located and held in position while punches *D* and *E* perforate a second set of holes. On the third stroke of the press, the work is blanked to a diameter of 2.222 inches by punch *K*, and the 0.8125-inch hole is drawn over punch *L* to form the 0.256-inch wide flange.

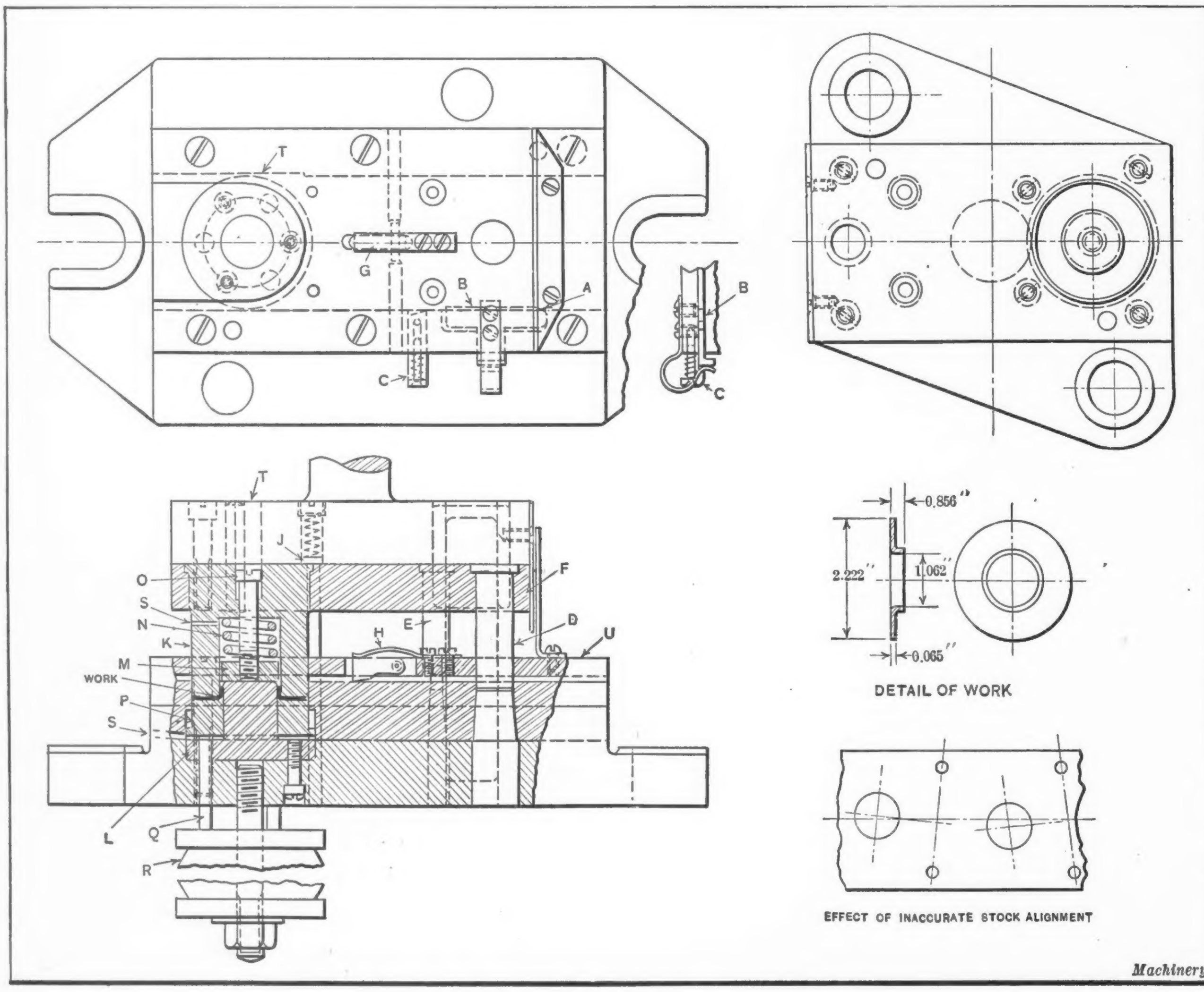


Fig. 1. Piercing, Flanging, and Forming Die used in the Production of Automobile Bearing Adapters

Normally, the spring knock-out *M* is flush with the face of punch *K*, this position being maintained by pressure applied by spring *N*; the knock-out is limited in its downward movement by screw *O*, which also serves as a means of adjusting the knock-out so that it will be flush with the blanking punch after the latter has been ground. As punch *K* descends it blanks and starts the drawing of the flange. The spring knock-out *M* performs the function of a pressure-pad as it recedes into the punch. The part of the blank that

is not drawn is gripped between the faces of the punch and the stripper *P*, pressure being applied to the latter member by three pins *Q* backed up by the rubber bumper *R*.

On the return stroke, stripper *P* ejects the blank from the die, and knock-out *M*, in turn, ejects it from the punch so that the blank is pushed back to its original position in the stock. Sufficient clearance is provided in the stripper plate *U* to permit the formed blank to pass out with the scrap stock. The blanks are removed by passing the flat side of the scrap stock under a rubber wheel. It will be noted that air vents are provided at *S* to prevent pneumatic pressure from building up and distorting the work in either the punch or die.

Design of Die

The punch and die are held in alignment by means of two pins or pillars which are fixed in the die bed and made a good sliding fit in bushings fitted to the punch-holding member. On the in feed side of the die, sheet-steel guards are so located as to prevent the operator from accidentally inserting his hand between the upper and lower die mem-

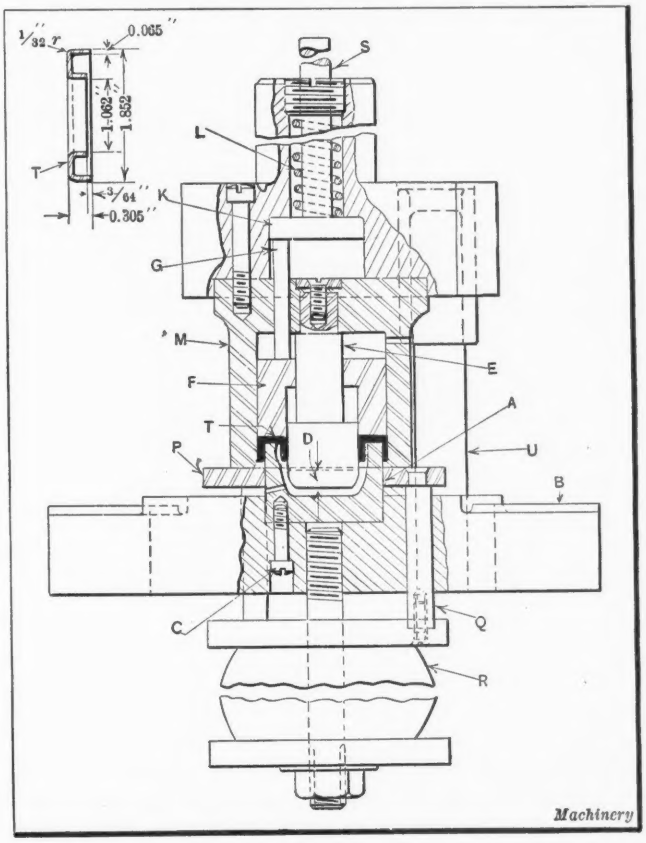


Fig. 2. Forming Die for Second Operation on Bearing Adapters

bers. From the illustration it will be evident that the die may be detached for grinding by simply removing six fillister-head screws. The back edge of the stripper is relieved 1/32 inch at *T* to allow sufficient clearance for the scrap stock where it is spread by the blanking punch. The spring stock guide *B* provides a means of compensating for variations in the width of the stock, and is necessary when the stock is sheared from sheets. The distance between the guiding edges of the stripper plate and the spring stock guide is ⅛ inch less than the specified stock width. The stock guide is therefore allowed to advance or recede to compensate for variations in the width of the stock.

If no stock guide were provided, the stock might be tilted as it is fed through the die, resulting in a condition such as shown in somewhat exaggerated form in the lower right-hand corner of Fig. 1. This condition would cause the flanged hole in the work to be eccentric with the periphery of the piece, which will give trouble when the blanking and forming operation is performed. It will be noted that features of both the progressive and combination types of dies have been incorporated in this design. While this is rather an unusual practice, the results obtained have demonstrated the practicability of the design.

Die for Second Operation

In Fig. 2 is shown the die employed for the second and final press operation on the bearing adapter. The press is inclined when this operation is performed. The 1.062-inch diameter flange is inserted in the cupped forming punch *A*. This punch is sunk into the die-shoe *B* and held in position by three fillister-head screws *C*. The cup is made 1/16 inch larger in diameter than the 1.062-inch flange to facilitate insertion of the work. As the ram of the press descends, the part *D* of the pilot *E* enters the blank and centralizes it. Knock-out *F* immediately grips the blank, pressure being applied through push-pins *G*, and knock-out plunger *K* by spring *L*. Knock-out *F*, which serves as a pressure-pad, is designed to recede ⅛ inch into the drawing punch *M* before the latter functions, in order that sufficient pressure may be applied at the point *T*. The outer edge of the blank is gripped between the faces of punch *M* and pressure-ring *P* until drawn to the shape indicated.

Pressure is applied to ring *P* through pressure-pins *Q*, which are backed up by the rubber bumper *R*. Pins *Q* are securely fastened in the pressure-ring and the bumper plate. On the return stroke, ring *P* rises to a level with punch *A*, and knock-out *F* ejects the blank from punch *M*. Should spring *L* fail to eject the blank, the knock-out rod *S* would strike a cross-bar in the ram, and effect a positive ejection of the work. The inclination of the press, in performing this operation, is sufficient to cause the blanks to slide out through the back into a suitable receptacle. Air vents are provided in punches *A* and *M* to prevent the work from being distorted due to pneumatic pressure. The punch and die members are aligned by pillars and bushings, as in the case of the die shown in Fig. 1. In order to flatten the work at *T*, rods *G* were made of sufficient length to cause knock-out *F* to exert a bumping action at the end of the downward stroke.

* * *

USING THE HEAT FROM HOT SPRINGS

Experiments have been made in France to determine if the heat of hot springs can be used for heating purposes. The low temperature of the water imposes evident limits on the industrial uses to which this source of heat may be applied, but experiments have been made with a view to using this water for domestic hot water installations and for heating purposes. One interesting use has been that of heating hot-houses for the raising of early vegetables. Taking as an example a spring yielding 1750 cubic feet of water per hour at 144 degrees F., a writer in *Comptes Rendus* estimates that if this water, after use, is discharged at 77 degrees F., it will liberate 1,850,000 kilogram calories, which he estimates to be equal to the burning of over one ton of coal an hour or approximately twenty-five tons a day.

* * *

BRITISH NATIONAL PHYSICAL LABORATORY

The National Physical Laboratory of Great Britain has been doing some very valuable work in connection with the mechanical industries, and the report for 1922, recently issued, indicates that this work is being carried forward with the same vigor as in the past. A new gear-measuring machine has been developed; a new design of high-speed grinding spindle for precision work, and especially for screw thread grinding, which has proved highly successful, has been brought out; and many investigations of great interest are in progress in the engineering department—particularly researches relating to lubrication. Researches on large bearings have also been undertaken, in addition to work done an alloys, partly on alloys of a high melting point and partly on alloys having a low specific gravity.

Helping Boys to Choose a Vocation

How the Continuation School at Milwaukee, Wis., Aids Boys in Selecting Trades or Other Work at which they can Earn their Living

CONTINUATION schools which boys and girls attend part-time are the direct result of laws enacted by many states during recent years, compelling boys and girls to be at least part-time students until they reach a certain age, usually sixteen or seventeen years. The studies in these schools are planned to give to the students practical instruction, half of their time being generally spent in shop work and the remaining half in academic work closely related to the shop work that they choose. It is impossible to teach a trade in these schools because of the short time the students attend—usually from five to eight hours per week—but the student may become familiar with the tools of several trades and be assisted in choosing the vocation for which he seems best adapted. Probably the hardest problem for the average boy is to decide what his life work shall be, and as continuation schools are of great help to him in making this decision, they deserve continued support.

This article will briefly outline the methods followed by the continuation school of Milwaukee, Wis., in helping boys to "find themselves." Instruction is given in sixty-five different kinds of work, but only the "home mechanics," machine shop, patternmaking and mechanical drawing courses will be considered here. There are approximately 13,000 day students and 7000 evening students in this school. For the year 1922-1923 the total expenses were over $500,000. The city received toward this expense from the state about $26,000, and from the Federal Government about $12,000. The work of the school is supervised by a local board, consisting of two employers, two employes, and the city superintendent of schools.

Functions of a Continuation School

The functions of a continuation school may be expressed as follows:

1. Training the pupil to be vocationally skillful.
2. Adding to the pupil's general elementary education.
3. Guiding the pupil into a suitable and useful occupation.
4. Teaching the pupil to become a good citizen.
5. Helping the pupil to use his leisure time properly.
6. Aiding the pupil to keep well.

Three general classes of students are handled at this school—part-time, apprentice, and rehabilitation students. Wisconsin laws require children between fourteen and sixteen years of age that are not attending a day school to attend a continuation school half-time, and those between sixteen and eighteen years of age to attend one day a week. If they are apprenticed, they need attend only one-half day a week during the first two years of their indenture. Apprentice students are taught only academic subjects closely related to their trade—things that their employer might not have time or not be inclined to teach. There are over 800 apprentice students at the school, and they are handled in classes separate from the part-time and rehabilitation students.

Rehabilitation and Part-time Students

Rehabilitation students are men who are 10 per cent or more disabled; many of them are wounded ex-service men, while the remainder have been disabled by disease or accident. This type of student attends school every day, being maintained by federal and state funds according to his disability. He is taught a more intensive course than the part-time student, and is converted into a skillful workman in a comparatively short time. The Federal Government watches the progress of these men, and when they become fairly skillful in a line of work and are physically capable of doing it, they are placed in an industrial plant. Compensation is continued, however, by the government and the state until it is absolutely certain that the man can support himself. There are about 200 students of this type in the school.

The part-time student is the one-day a week student who has not reached the age of seventeen years, but has a permit to work. This student is given a preliminary try-out in the "home mechanics" department, so that he may intelligently determine upon a vocation, and is then given shop and academic instruction in the work he chooses. The employers of these students must pay them for the time spent in school, and this eliminates one common cause of absenteeism in other states. Again, should

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The time has passed when progressive communities question the necessity of including in their complete educational program a definite plan for vocational education. We are commencing to realize that for society to compel a child to attend school for eight or ten of his most formative years implies a responsibility that cannot be escaped. To imagine that we are meeting that responsibility when the vast majority of children leave school absolutely unprepared for the problem of earning a livelihood is to be blind to the real facts of our responsibility. A program of education for a city or a state which denies to boys and girls this fundamental preparation for the problems of life is inadequate, and the school offering such a program can no longer be wholly justified as a forward-looking social institution.—Professor Edwin A. Lee, Indiana University.

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students be absent because of indolence or some similar reason, their employers can fine them one and one-half times the compensation they would receive while attending school, and their working permits are revoked if absence becomes continual. The evening classes are conducted for students of any age who may want to supplement their knowledge of a trade. Students residing outside of Milwaukee, but working in that city, must attend the continuation school.

"Home Mechanics" Department

All part-time students under sixteen years of age, on entering school, are placed in what is known as the "home mechanics" department, where they are given a variety of work to see if they have a natural aptitude for any vocation. Boys over sixteen years old usually have had the benefit of manual training in grammar and high-school grades, and have a specific vocation in mind. While in this department the boys become acquainted with one another, and with the faculty, and they become familiar with the purpose and methods of the school, so that at the end of a five-months' term they generally have no trouble in deciding upon some line of work. When they enter the school they often have decided on a certain trade, but have no real conception of it, and in many cases select another one before the completion of the term. However, they are always given a tryout on their first choice if they desire to have it.

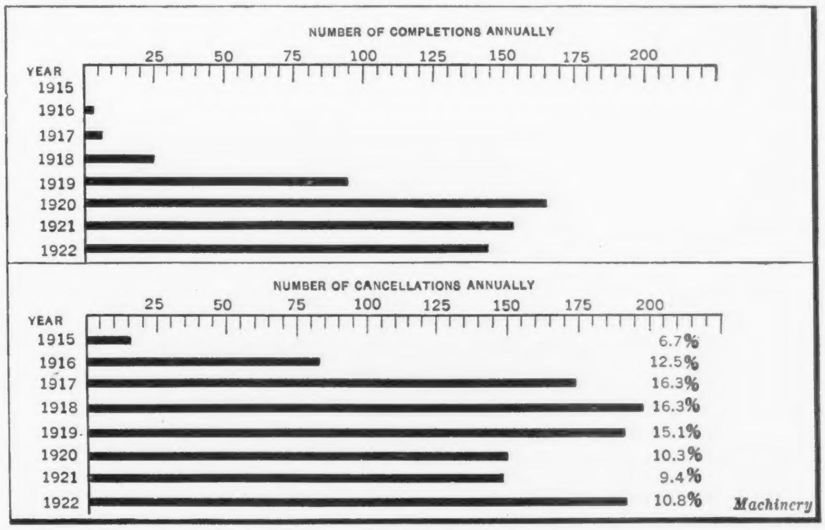

Fig. 1. Charts showing the Number of Indentures completed and cancelled annually in the State of Wisconsin

In this department the boy is given instruction in things that will be of value to him about his home, with which he may be more or less familiar, such as repairing faucets, painting, fixing electric light circuits, soldering, and putting locks on doors. In one division of this department a small two- or three-room bungalow is completely erected and painted to give the boy worthwhile experience. He is also instructed in drawing and elementary wood- and metal-work. In connection with the latter, he is taught how to file, hacksaw, lay out work, drill, etc. Various things that can be put to practical use are made, such as foot scrapers, shelf-brackets, rough inside and outside calipers, clamps, and wrenches. These parts can be purchased by the boys at the actual cost of the materials used. The various steps in making each part are clearly shown to the student by examples on the boards.

The academic work for the student in the "home mechanics" department consists of instruction in building and loan matters, parcel post problems, meter reading, etc. Some boys are taught shop arithmetic, the geometry of circles, and the solution of triangles, and it is necessary to teach fractions and decimals to many. Generally from 800 to 1000 students enter this department at the beginning of a school year, and it provides an excellent means of keeping unskilled boys from coming in contact too soon with high-priced machines. Considerable effort is made by the teachers of this department to interest the boys, and their work is praised whenever possible.

Advanced Machine Shop Work

If at the end of a term in the "home mechanics" department a student chooses to follow the machine shop course, he enters a school-room well equipped with all the common types of machine tools, including an automatic and a turret lathe. No attempt is made to teach the boy a trade, but he is given instruction in the operation of each type of machine, until he is thoroughly familiar with it before he receives instruction on the next. Under this system the boy need not be in the department long before he can accept a position as a machine operator. The lathe is the first machine on which he receives practice, and he is taught to turn work to gages within specified limits and to produce threaded parts. Machines of the same type are of different makes, so that the boy must become familiar with the method of making adjustments on several styles. There are about 250 boys in the machine shop classes, but the instruction is entirely individual.

Academic work closely related to the shop instruction is given to the boys by the same instructor, the policy of the school being to have one teacher handle a certain group of boys in all their work with the exception of the civics, health, and science classes. By this arrangement the boys become better acquainted with their instructor, and as he is always a capable man who has had actual experience at the trade he teaches, he readily eliminates all unnecessary theory. In connection with mathematics, the students are taught how to calculate pulley and gear speeds, and feeds and speeds of machines; in the course in mechanical drawing, they are taught how to read blueprints, and how to make freehand sketches and drawings of details. In fact, mechanical drawing is taught to all boys, because it is contended that every mechanic should be able to read a blueprint, which is the language of the shop.

For the English class, a subject is given out weekly from the office of the director, on which the boys are required to write a composition after a discussion by the teacher and boys in the class-room. This weekly question is the same for all classes, and may concern the ventilation system or some other equipment of the school, or it may be a general topic. A question more closely related to the shop work of the boys can be substituted by the teacher for the weekly composition, provided the topic substituted has been previously submitted to the director and approved by him. Grammar is incidental and not formal. In science, the boy hears lectures on the manufacture of iron and steel and similar subjects.

Patternmaking and Mechanical Drawing

In the pattern shop boys are taught to operate the various standard types of woodworking machines, to use the hand tools of this trade, to distinguish between the different kinds of lumber, to construct patterns, etc. The mathematics in this department consist of problems in board measure, finding the proper angle to grind machine and hand tools, estimating the cost of making patterns, etc. The drawing course is similar to that taught boys in the machine shop. In science the students are taught applied physics, and are shown the effect of heat and air on lumber, the principles of levers, wedges, etc. Lectures are given on the manufacture of screws and nails, and the boys are taught the gages of screws, the names of different types of

nails, etc. A typical question in the English class is "Why are Patterns Shellacked?"

Mechanical drawing students are taught the use of drawing instruments and supplies, how to make detail and assembly drawings, sketching, and the method of producing blueprints. In the science class these students are taught such subjects as physics and school-room chemistry, experiments being made to show the results of the application of heat to metal, etc. Mathematics from addition up to square root, algebra, and strength of materials, is taught. The civics course is identical with that taught other students, and the English course is similar.

It would be unreasonable to assume that every boy, after having instruction in the "home mechanics" department, will select the trade for which he is best adapted, and so, when a period of three months spent in the selected work has elapsed, he may choose some other kind of work if he desires. This three months' probation may be continued until the boy has found an occupation that he likes. However, the turnover is generally small, and in the drawing classes is only about 6 per cent out of an average of 120 boys.

Inducing the Boys to Learn a Trade

All the teachers endeavor to impress upon the boys the desirability of knowing a trade. It is pointed out that while at the present time they may be earning more money than apprentice boys, still all journeymen earn at least $500 more a year than helpers in the same trade, and it is

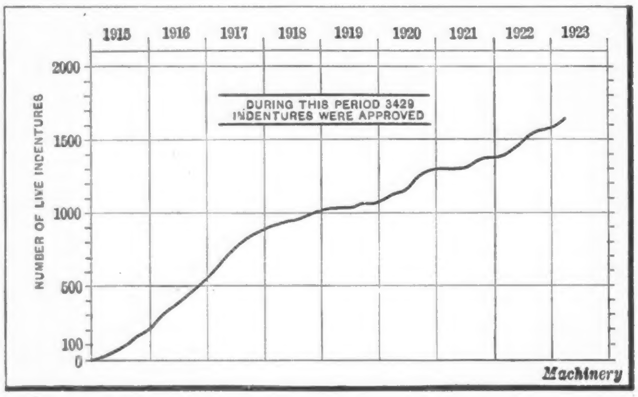

Fig. 2. Number of "Live" Indentures between the Years 1915 and 1923

therefore wise to work at lower wages for a short time and learn a trade that will be more profitable in the years to come. The Industrial Commission of Wisconsin is primarily interested in this phase of industrial education, and makes arrangements with employers to accept apprentices. The commission periodically sends a representative to the school with contracts of indenture, which the boys and their parents may fill out.

A boy must be sixteen years old before he can be lawfully apprenticed in Wisconsin, and the indenture must be signed by the apprentice, his father, mother, or guardian, the employer, and a representative of the Industrial Commission. There is usually a three-months' probation, and the indenture for the metal trades specifies a certain number of months' instruction on the different types of machines. The rate of pay in these trades ranges from 18 to 35 cents per hour, for a four-year indenture, and a bonus of, say, $100 is usually paid to the boy upon completing the contract, to pay for a kit of tools.

Representatives of the Industrial Commission periodically visit shops in which apprentices have been placed, to ascertain the nature of the work that the apprentices are doing and see that the contracts are being lived up to by both the apprentice and his employer. Should either of these fail to meet the stipulations, he may be fined not less than $1 nor more than $100, and either party may make complaints to the commission, which has the power to dissolve contracts.

As previously mentioned, apprentice boys are compelled to attend the continuation school one-half day a week during the first two years of indenture, and are taught definite courses in trade mathematics and theory. Should an apprentice absent himself from school without a satisfactory excuse, his employer can deduct treble the amount of wages that he would ordinarily be paid for the time in school. Manufacturers of Milwaukee constantly make application for apprentices, and there have been as many as 300 unfilled applications at one time. During the year 1922-1923, over 400 boys apprenticed themselves from the Milwaukee school.

Growth of the Wisconsin Apprentice System

From the time this apprentice system was started—in 1915—to the end of the first quarter of 1923, a total of 3429 indentures were approved by the commission. Of this number 618 have been successfully completed, and 1177 cancelled, 1634 "live" indentures remaining. From a comparison of the number of cancellations and completions, it would seem at first that the ratio of cancellations to completions is about two to one but this is not true, because under the "live" class there are many apprentices who have spent two, three, and almost four years in their indenture, and this fact does not show in the figures. A better comparison can be made by referring to the charts in Fig. 1. The upper chart shows the number of completions annually, and the lower one the number of cancellations. It will be seen that during the first four years the cancellations were very high compared with the number of completions, but reference to the percentages in the cancellation chart shows that the percentage is really low when compared with the number of "live" indentures.

By the year 1919 the number of completions was almost 50 per cent of the number of cancellations, and in 1920 and 1921 there were actually more completions than cancellations. Fig. 2 shows graphically the number of "live" indentures at any time during this period, deductions being made for completions and cancellations. The majority of cancellations occur at the end of the three month's probation, and so neither the employer nor the boy has lost a great deal financially from the experiment. As a result of this system employers of Wisconsin have become more interested in developing journeymen, and there are more boys ambitious to learn a trade.

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AUTOMOBILE HORSEPOWER RATING

The following formula for horsepower rating for determining the taxable horsepower of automobile engines in Germany is given in *Commerce Reports:*

$$N = 0.3 \times n \times d^2 \times s$$

in which

N = horsepower rating to be determined;
n = number of cylinders;
d = diameter of cylinders, in centimeters; and
s = length of stroke in meters.

The rating obtained by this formula is much less than that obtained by using the formula of the National Automobile Chamber of Commerce in the United States.

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HIGH RAILWAY TAXES

According to data published by the Committee on Public Relations of the Eastern Railroads, 143 Liberty St., New York City, the railroads of the United States are today paying more in taxes than they are paying in dividends. These figures are from the records of the Interstate Commerce Commission. Ten years ago the total dividends paid to railroad stockholders amounted to two and one-half times the amount of taxes paid by the railroads. Taxes have increased from approximately $127,000,000 to $301,000,000, while dividends have decreased from $322,000,000 to $271,000,000. In 1922 the total amount of taxes paid was the largest, and the amount of dividends paid the smallest, in any one year since 1913, with the exception of 1915, when dividends reached a low level.

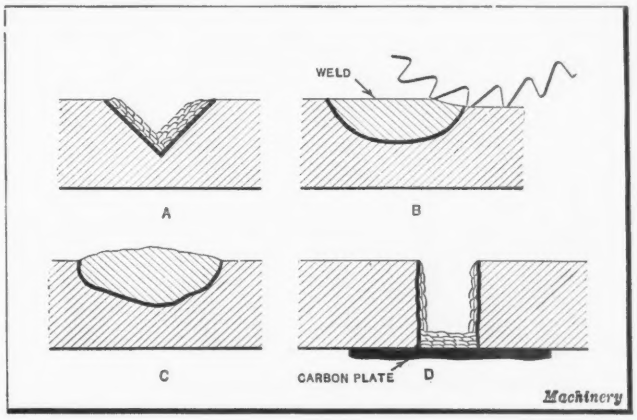
Arc-welding Cast Iron Without Preheating

By J. P. KRYZA, Factory Manager, and H. E. BRADFORD, Sales Manager,
The Super Arc Welding Machine Co., Detroit, Mich.

PREHEATING cast-iron parts prior to welding them is necessary with most types of arc-welding equipment in order to obtain good cohesion of the welding material and the original casting surfaces, relieve strains, compensate for expansion and contraction, and eliminate gas pockets. In addition, a reheating process is frequently required after the operation, to relieve strains produced by welding and to anneal hard portions of the deposited material. Both preheating and reheating are necessary because of the fact that the casting surfaces at the weld are melted in the process.

In an arc-welding method developed by the Super Arc Welding Machine Co., Detroit, Mich., neither preheating nor reheating is required, because the surface welded is only slightly fused; in fact, the temperature of the welded surface is never higher than the fusing point. Therefore there is no change in the structure of the casting, and although it may be thought impossible to obtain cohesion of the welding material and the casting without actually melting the metal in the vicinity of the weld, the results are entirely satisfactory. In addition to this advantage, welds made by the process are machineable and at the same time have a high tensile strength.

In this method a short arc is drawn between a metallic electrode and the surface being welded, the metal melted from the electrode being deposited in a series of laminations, as shown at *A* in the accompanying illustration. The rate at which these laminations are produced depends on the frequency of the alternating current used; thus if 60-cycle current is used, the laminations are deposited at the rate of 60 per second. The localized heat in the vicinity of the electrode point is sufficient to force the fused electrode to penetrate into the unmelted casting from 1/16 to 5/16 inch. The electromotive force actually jams the fused electrode through the minute pores of the casting.



Welds made by the Arc-welding Process without preheating

Because the principle of this method does not conform to the generally accepted theories concerning arc welding it has been termed the "erratic" process. The short arc is always under the control of the operator, and hence distortions at the weld are eliminated. The heat radiation never extends more than ½ inch from the weld. One of the important features of this arc-welding process is the fact that white iron can be welded, which is impossible with a constant-arc equipment, because the casting breaks as it is heated. Steel cannot be satisfactorily welded by this process, probably because the heat delivered by the electrode is not constant.

The welding equipment consists essentially of an alternating-current transformer with a lead for connecting to a circuit and a lead to the electrode. This transformer has six different taps to afford a means for regulating the voltage of the current supplied to the electrode and thus controlling the degree of heat and the amount of electromotive force to suit the thickness of the casting at the place being welded. Commercially pure iron wire is used for the electrode instead of the common cast-iron rod. The diameter of the electrode varies from 1/16 to 5/32 inch according to the particular work the size controlling the amperage of the current at the arc.

Characteristics of Welds made by the Process

Welds made by this process are blue instead of white, which indicates that the castings have a low temperature. The tensile strength of a welded section is from 15,000 to 25,000 pounds per square inch more than that of a cast-iron section of the same area. In a test conducted at a large automobile plant under a hydraulic press on a test bar 2½ by ¾ by 12 inches, a pressure of 5 tons was required to break the specimen, and the break occurred ¾ inch from the weld. The amount of penetration in a weld depends upon the temperature to which the casting surfaces are heated by the electrode.

No difficulty is experienced in machining welds, because the metal of the casting does not become hot enough during the process to crystallize. Where the filler metal penetrates into the original casting, however, there is a tough vein ranging from 0.003 to 0.005 inch in width. This characteristic involves no especial difficulty in machining, because the tool need cut only through the narrow width of the vein, as shown at *B*, rather than along its length. When a hole is to be built up and then reamed or ground to size, it should first be drilled about 1/32 inch larger than the finished size. Then, in machining it after the filler material has been deposited, the reamer or grinding tool will not come in contact with the tough ring of penetration.

Applications of the Process

One of the most successful applications of this process has been the reclaiming of automobile cylinder blocks found after machining to have one or more blow-holes in the cylinder bores or in other important locations that would ordinarily require scrapping of the casting. In one automobile plant alone, thousands of cylinder blocks have been saved from the scrap heap by the application of this welding method. When blow-holes are discovered in cylinder bores after the machining of the block has been started, the practice is to finish-grind the cylinder, then fill in the blow-hole, and finally grind down the raised surface of the weld. The view at *C* shows the appearance of such a weld before the raised surface has been ground down. The reclaimed cylinder then goes to finished stock, the same as blocks in which no foundry defects are discovered. Another application in automobile plants is the reclaiming of cracked water jackets. Rebuilding of valve seats is one application in automobile service stations. The operating costs of the equipment are low, the cost for electric current, when a machine is used continuously, being less than 50 cents a day.

In welding hollow sections with constant-arc direct-current equipment, the sections are expanded by the heat and new cracks are produced as the first is welded, but in the

process here described this does not occur, because the heat is so highly localized that distortion and subsequent cracking is impossible. Cracks in cast-iron boiler sections from 50 to 60 inches in developed length and ¼ to ⅜ inch in width have been satisfactorily repaired. When a crack in a casting is comparatively wide, the welding operation is facilitated by holding a carbon plate against the side opposite the electrode, as shown at *D*. In no instance is it necessary to tap holes along each side of a crack, assemble studs in the holes, and tie the studs together with a melted electrode, as is common practice with constant-arc equipment. Such a job merely constitutes placing a layer of metal on top of the crack, and cannot be considered welding in the true sense of the word.

* * *

DESIGN AND CONSTRUCTION OF CAN DIES

By ARTHUR MUMPER

Dies for making the ends for sheet-metal cans used for preserving fruits and various food products are all designed along nearly the same lines. This is especially true of dies for the old style wax-top can, the tops and bottoms of coffee containers, and the comparatively new sanitary can ends.

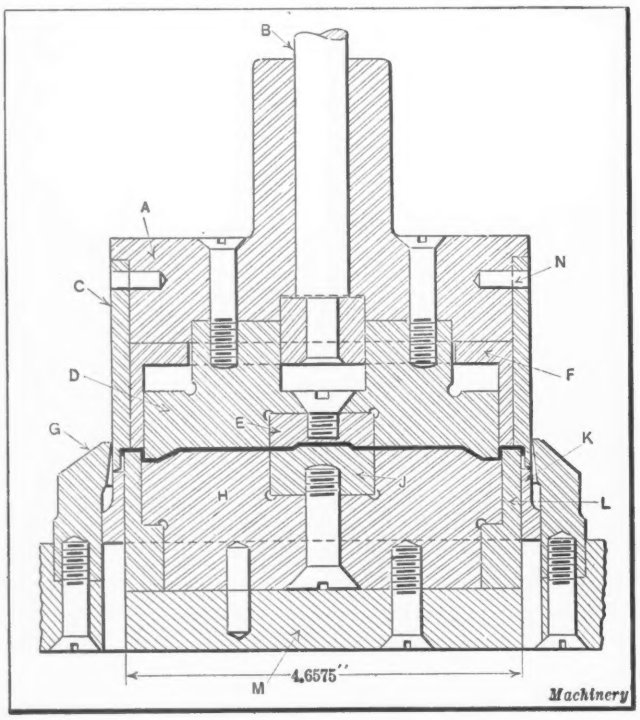


Fig. 1. Die for blanking and forming Bottom End of Coffee Can

The different parts commonly found in these dies are similar to those employed in the die shown in Fig. 1. This die was designed to cut and form the bottom end of a coffee can at one operation. The punch-holder or body *A*, knock-out rod *B*, punch shell or ring *C*, punch core *D*, embossing pad *E*, and knock-out ring *F* are the essential parts of the top section or punch proper. The cut-edge die *G*, die core *H*, bottom embossing pad *J*, draw-ring *K* (sometimes called stripper ring), die ring *L*, and the casting to which these parts are bolted or fitted make up the bottom section, or what may properly be termed the die.

The top part of the die, or the punch body *A*, is made of machine steel, and is finished to the required size. The punch shell *C* is first roughed to within 1/32 inch of the required size, and then annealed, after which the end that goes on the punch body is bored to a shrink fit. This part is never made very hard, as it frequently has to be upset and just toughened up. In assembling, this part is heated to a cherry red, and then placed on the punch body and set in oil to cool. In this way, the shrinking on and hardening is done at the same time. After cooling, punch shell *C* is

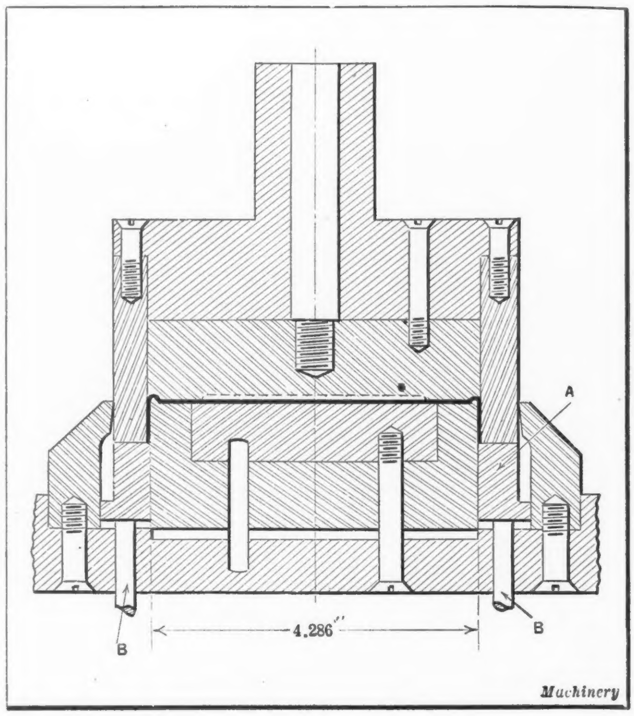


Fig. 2. Blanking and forming Die for Coffee Can Top

turned to the finish dimensions and secured by 3/16-inch dowel-pins *N*. The knock-out rod *B* is a sliding fit in the stem of part *A*.

The knock-out ring *F* is tool steel, and is hardened and ground. An allowance of 0.018 inch is left on the outside and 0.015 inch on the inside for grinding. This is not any too much, as this part is just a shell with a large hole cut in the top to allow the punch core lug to pass through, and consequently the part changes shape considerably during heat-treatment. The punch core *D* and the die core *H*, in this instance, did not warp enough to warrant grinding on the face. The cut-edge die *G* was drawn to a light yellow on a hot plate. In some shops this piece is quenched and then set back in the furnace with four pieces of very thin sheet lead bent over the edge, and left there till the lead melts. This gives good results, but it is not quite so reliable a method as the positive drawing to a color and testing with a scleroscope. The cut-edge die *G* is forced into the die-casting *M*. The die core *H* and the die ring *L* are ground to a force fit. The knock-out ring must have a free

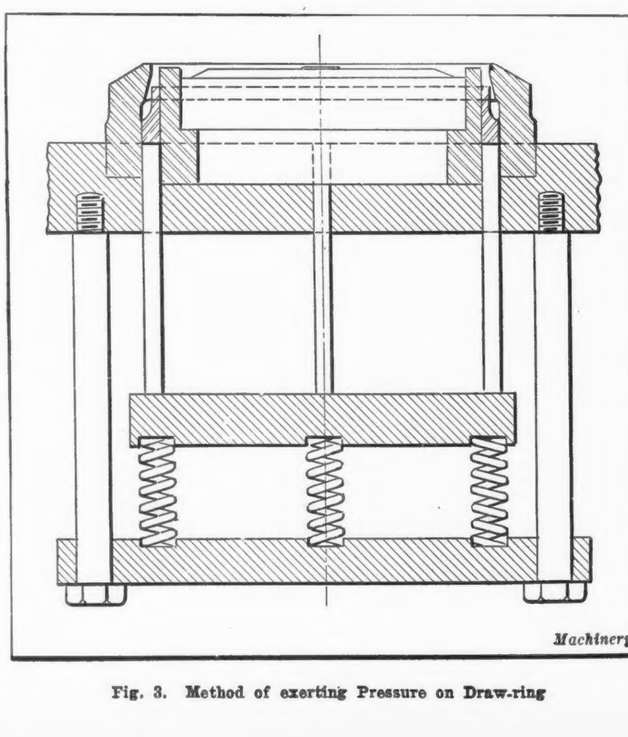


Fig. 3. Method of exerting Pressure on Draw-ring

sliding movement in the punch between the punch and the punch core.

In Fig. 2 is shown the die for the top of the coffee can. This end of the can is an air-tight fit over the body. There is no knock-out, as the end stays on the die and is forced off by the stripper ring *A*, which is operated by four pins *B* passing through the bolster plate. A scleroscope test of 90 is ideal for this class of work.

In Fig. 3 is shown the method of exerting pressure against the draw-ring. In this, as in other dies for similar purposes, it is necessary to have the metal to be drawn held firmly in place until the forming part of the die completes its work. Although this is a fairly quick-acting die, operating at 60 to 80 strokes a minute, if the draw-ring does not have pressure enough under it, the tin plate will shift its position between the instant of blanking and the time the forming takes place. It is not necessary to go into detail concerning Fig. 3, as the illustration is self-explanatory. The same apparatus is used for both dies.

In heat-treating the dies described in this article, the dies were carefully pre-heated before finally being placed in the furnace for the regular heating. The temperature was watched constantly, and as soon as the critical point was reached, the dies were quenched in water until they could hardly be held in the hands. They were then placed in a tank of oil heated to about 175 to 250 degrees F. After being allowed to remain in the oil for about twenty minutes, they were placed on a hot plate and drawn to the desired color. From the time they were preheated until the temper was drawn, they were not allowed to cool. Keeping the dies fairly warm until the final drawing of the temper eliminates, to a considerable extent, the possibility of breaking.

* * *

ECONOMY IN GRINDING WHEEL DRESSING AND TRUING

By M. L. CLIMO, General Manager, The Ross Mfg. Co., Cleveland, Ohio

An important factor in the improvements made in methods of dressing and truing grinding wheels has been the "mass production" of automobiles. Vast quantities of ground automobile parts, the increased number of grinding wheels, and keen competition among car and parts manufacturers have made it worth while for several companies to specialize in better and more economical devices for grinding wheel maintenance. Experiments have aimed mainly at two results—less expensive truing and dressing tools, and tools that would do the work more quickly; this meant, of course, tools that would either supplement the diamond, or, wherever possible, replace it entirely. The initial cost of diamonds, their chipping, breaking, heating, and rapid wear, and the difficulty in selecting good stones, the likelihood of losing the jewel from the shank, and the employment of inexperienced men combined to make this desirable from the viewpoint of economy. Consequently, although the diamond still holds a place of its own in special cases where an extremely fine finish is necessary, many other dressing tools are now in use that are effecting marked savings. While some shops have eliminated the diamond entirely, the majority have merely restricted its use and are applying the new tools for preliminary cuts into the wheel, which were previously especially hard on diamonds. There are, however, a great number of wheels in such shops which are kept in excellent condition by the new truing and dressing tools alone. These wheels do good work on crankshafts, camshafts, wrist-pins, tappets, axles, and other parts.

Types of Dressing Tools

Non-diamond dressing tools are of three types: There is, first, the device consisting of fragments of broken wheels or other abrasive crystals held in metal tubes. Second, there is a type known generally as the "star dresser," because it is composed of several star-shaped steel stampings placed in a holder so that they may revolve freely when brought into contact with the grinding wheel. Third, there is a closely machined and fitted ball-bearing tool, consisting of a hardened steel cylinder having on its curved surface a succession of sharp-edged slots which cross diagonally. The slots vary in size and spacing according to the purpose for which the tool is required, and in number from twelve to twenty-four; or, the cylinder is built up from a series of tempered disks containing teeth staggered to form a certain pattern on the contact surface. This is usually a roughing tool. The cylinder revolves on a hooded, hardened and ground spindle at the end of a shank.

While there are a great number of holders made for special grinding machines, the majority of cylinders are mounted either in a straight holder, which has the spindle at right angles to the shank, or in an offset holder, which has the spindle axis parallel with that of the shank. The application of each holder is obvious. Incidentally, the offset holder has become very valuable in dressing the sides of wheels, an operation particularly destructive to diamonds. The same is true of the straight holder when used for pin-grinding in conjunction with pot chucks on various types of grinding machines.

Dressers of the third type mentioned are clamped in the usual manner to the grinding machine, and the surface of the cylinder is applied against the cutting face of the emery wheel. There is little grinding action on the tool, since both contact surfaces are moving at the same speed. The effect of the pressure is, however, to loosen the top layer of blunted crystals, which fall away, exposing a new cutting surface. The depth of the cut into the wheel is governed by the type of cylinder and the kind of work the grinding machine is expected to turn out. It may vary from 0.003 inch with a finishing tool to 1/32 inch with a roughing tool, although the latter amount is rarely removed from a wheel at one cutting. Often both a roughing and finishing tool are used, and then, when an exceedingly fine finish is required, a final dressing is given the wheel with a diamond.

One of the chief advantages of the ball-bearing tools is that different types can be used to marked advantage on wheels of different grain. The same applies in the case of wheels of similar grain but turning at different speeds. A sixteen-slot Ross finishing tool, for instance, is best for a wheel turning at 800 revolutions per minute, while an eighteen-slot tool is recommended for 1100 revolutions per minute. Care in using the proper tool is definitely indicated by faster grinding operations. The wheel retains its efficiency longer before redressing, and the tool does the work more quickly than the diamond, and with less care on the part of the operator; furthermore, so-called "diamond marks" on the wheel are eliminated. Where the piece is to be lapped or polished, the use of carefully selected dressing tools has often cut the polishing time approximately in half.

The cost of dressing tools of this kind is such that several may be bought for the price of a good diamond dresser, and the average life of the cutting surface of the tools is considerably longer. An additional point of economy is that worn cylinders can be replaced in the original holder, a credit usually being made on the price of the new cylinder when the worn one is returned to the manufacturer. Points to be observed in the purchase of truing and dressing tools, in addition to determining the best cylinders for a specific purpose, are rigidity of construction, quality of spindle bearings, provision for protection against dust penetration, and proper lubricating devices.

* * *

Industrial machinery imported into Italy from the United States in 1922 had a value of $516,000. In that year 50 per cent of Italy's total machinery imports came from Germany, 15 per cent from Great Britain, 10 per cent from Switzerland, 7.4 per cent from the United States, and 5.7 per cent from France.

Saving Worn Parts by Electro-deposition

By J. D. ALLEY, Research Department,
Westinghouse Electric & Mfg. Co., East Pittsburg, Pa.

IT is the purpose of this article to describe a simple process, developed at the Westinghouse Research Laboratory, for building up worn parts by the electro-deposition of iron. This process has been used to build up shafts, pins, bolts, gear centers and similar parts, and with very little modification can be employed to build up the worn surfaces inside automobile engine cylinders.

Although the electro-deposition of metals for various purposes has been practiced for a long time, it is only within the last few years that the process has actually been put to use in the recovery of worn parts or parts accidentally machined under size. The British were the first to make practical application of the electro-deposition of iron for this purpose. During the recent war they had two organizations; one in England and one in France, working independently of each other. These organizations worked along somewhat different lines but were accomplishing the same end, namely, the building up of worn automobile and airplane parts. One of these organizations alone recovered over 6000 worn parts, which represented an immense saving. In a great many cases automobiles and airplane engines came back to the repair shop after further service, and thus there was an opportunity to inspect the recovered parts. These inspections showed that the parts had served just as satisfactorily as new ones.

In spite of the fact that several articles were published just after the war in regard to this work, automobile men and the public in general have not awakened to the full possibilities of building up worn parts by electro-deposited iron. Possibly this is because it is generally believed to be a complicated process requiring careful chemical control and likely to fail unless carried out by a technical man.

Research Work to Develop a Practical Process

The Westinghouse Research Laboratory became interested in this problem and decided that if it were possible to simplify the process, it could be made a very valuable aid to repair men in general. So far as is known, the Westinghouse company is the only one in the United States that has done any work along this line. The research work has extended over a period of two years, and out of an immense amount of work with different solutions, addition agents, varying current densities, etc., there has been developed a standard method of procedure. Commercial salts are used and a current of sufficient density is employed to permit all ordinary repair work to be removed from the plating bath at the end of two or three hours. The cost of building up and machining is kept low enough so that it will pay to reclaim a piece with this process rather than use a new one. While the research work has been carried on, over 200 pieces have been recovered for the Westinghouse plant, thus making the process help pay for its own development. This company is now installing a service station in the Pittsburg district to handle all kinds of work that can be reclaimed by electro-deposition.

The Plating Bath

For all-round simplicity, a plating bath made up in the following proportions has proved best: 2.5 pounds of commercial ferrous ammonium sulphate per gallon of city water plus a small amount of ferrous carbonate (freshly precipitated and kept under water in order to keep the solution practically neutral) plus a small amount of powdered charcoal, which helps to prevent pitting. The equivalent amounts of commercial ferrous sulphate and ammonium sulphate may be substituted for the ferrous ammonium sulphate. If the solution is made up from the ferrous sulphate and ammonium sulphate, the granular or "crystal meal" ferrous sulphate should be used. The ammonium sulphate must prove to be free from sulphocyanate when tested with ferric-sulphate or ferric-chloride.

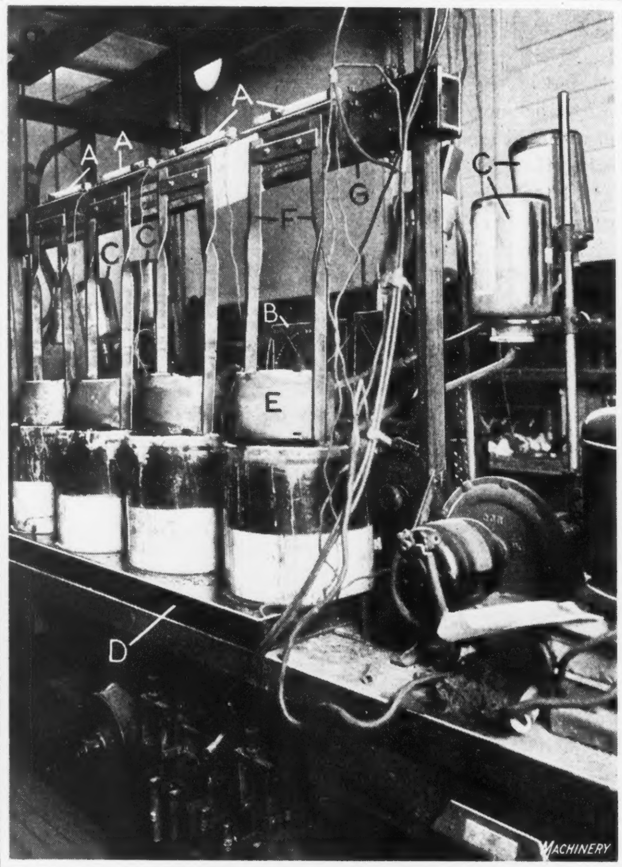


Fig. 1. Equipment for building up Worn Shafts by the Electro-deposition of Iron

All small pieces are plated in earthenware crocks, and large pieces in lead-lined wooden tanks or stoneware tanks. Waterproof cement tanks can also be used. The anodes are made of "Armco" iron, cylindrical in shape. Micarta disks with a hole cut in the center are fitted in each end of the anodes. The pieces to be plated are made the cathode and held stationary so that they extend into the plating solution through the holes in the micarta disks. The anodes are attached to a device which moves them up and down, thus keeping the plating solution stirred and the ferrous carbonate and charcoal in suspension. The temperature is held at approximately 60 degrees C., a few degrees variation either way not doing any harm. A current density of 0.43 ampere per square inch is used. This deposits metal at a rate that increases the diameter 0.006 inch per hour.

This method of procedure applies only to pieces such as shafts, bolts, pins, etc. For pieces such as gear centers, automobile cylinders, etc., where the inside diameter needs to be reduced, the anode is made to go down through the center, and micarta rings are fastened to the anode to obtain the required stirring. The current density could be raised considerably, but as the density specified adds the deposited material at the rate of 0.003 inch on a side or increases the diameter at the rate of 0.006 inch per hour, it is evident that the ordinary repair job requiring an increase in diameter of approximately 0.010 inch to 0.020 inch can be quickly completed.

Method of Cleaning Work

Probably the most essential part of the process and the part that requires the most careful attention is the cleaning of the piece before plating. After trying out different methods, it was found that the best way to clean the work in order to insure that deposited material would adhere satisfactorily was to clean it electrolytically. With this method the piece to be plated is made the cathode in an alkaline solution consisting of 6 to 10 per cent of caustic soda and 5 to 10 per cent of commercal sodium carbonate, using a current density of 3 amperes per square inch for a period of three minutes. It is then washed in running water, transferred to a 30 per cent commercial sulphuric acid solution, and given a high enough current density to make it passive for a period of three minutes or longer, according to the condition of the piece. If it is free from rust to begin with, three minutes is long enough, but if especially rusty it requires a longer time.

The piece being cleaned should come out of the acid cleaning solution bright and silvery except in the case of cast iron, which will be black due to the graphite content. When taken from the acid cleaning solution, the piece is washed in running water and immediately transferred to the plating bath without giving it a chance to dry and form a thin film of rust. It is essential for the current density to be kept high enough (at least 3 amperes per square inch) in the acid solution so that the piece being cleaned is kept passive. When passive, there is a rapid evolution of gas, and the piece is bright and silvery in appearance when it is taken out, but if allowed to become active, it has a dull black appearance. When a piece is covered with oil or grease it is cleaned with gasoline or benzol before being cleaned electrolytically.

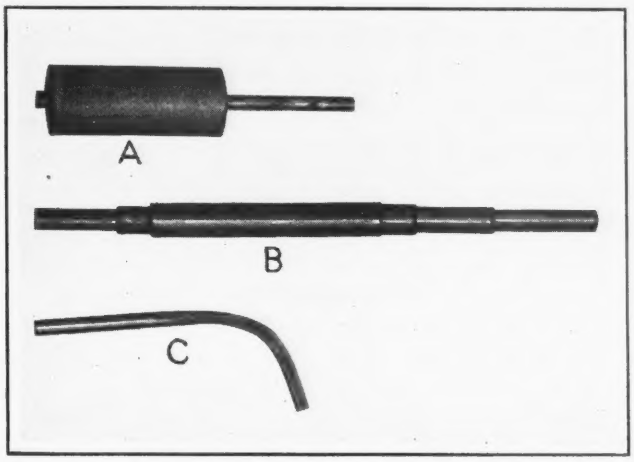


Fig. 2. Examples of Work built up by the Electro-deposition Process

If the method of cleaning and plating here described is followed, the deposited metal will be free from pits, bright and velvety in appearance and will adhere perfectly to the parent metal. The following tests will give some idea of the tenacity with which the deposited metal adheres to the work. First, the test rod was held in a vise, bent to a right angle, straightened, then bent to a right angle in the opposite direction and again straightened, without any sign of chipping or cracking of the deposited metal. Second, the test rod was heated and forged without any sign of the deposited metal breaking away from the parent metal. Third, two sets of test rods were accurately ground to size so that one set was 0.010 inch smaller in diameter than the other. Both sets were then built up and reground to the same size, so that one set had 0.001 inch of deposited material on a side and the other set had 0.006 inch on a side. A hole 0.0005 inch smaller than the finished test rods was drilled and reamed in a piece of cold-rolled steel one inch thick, and the rods were pressed through the reamed hole and back again without any sign of the deposited material stripping.

It is impossible to build up a piece accurately to size, and so it is necessary to build the work up a few thousandths over-size and then turn or grind it to the finish size. This method of recovery can be used with steel, cast iron, or casehardened material, and the deposited material can be casehardened when necessary.

Restricting Addition of Metal

Usually there are portions of the work that are not to be plated or built up but that must nevertheless be immersed in the plating solution. For protection, these parts are coated with a mixture of 90 per cent hydroline and 10 per cent paraffin. The hydroline must have a high enough melting point so that it will not soften and run at 60 degrees C. This protective coat is applied by melting the mixture and then dipping the piece to be coated, or by painting the mixture on with a brush. After the piece is plated, the protective coat can be readily removed by washing with benzol.

Maintenance of Plating Equipment

When a repair shop of this kind has once been equipped, the chief operating expense is labor. The plating baths should run six months, at the least, without any attention except the adding of water to replace that lost by evaporation and the adding of a small amount of ferrous carbonate and charcoal once a week. The cost of the current used in cleaning and plating is small. The anodes are gradually used up and have to be replaced by new ones, but the initial cost of an anode is distributed over a number of repair jobs, making the amount added to an individual repair job small. The operator is chiefly concerned in getting pieces ready to be plated and cleaning the pieces that have already been plated. As they require no attention while in the plating bath, one man can handle enough pieces in a day to make such a shop a paying investment.

Necessary Equipment for a Small Plant

The limiting factor in the size of a plating plant is the amount of current needed for cleaning. At the rate of 3 amperes per square inch, a 1000-ampere generator set would clean a piece having an area of 333 square inches, which is the equivalent of a shaft 4 inches in diameter and 26 inches long or a shaft 6 inches in diameter and 17 inches long. It is necessary, then, before putting in equipment for building up parts by the electro-deposition of iron, to calculate beforehand the surface of the largest part that is to be cleaned and order the motor-generator set in accordance with it.

The following equipment would be required for a small plant: One 30-volt motor-generator set, 500 to 1000 amperes capacity, according to capacity needed for cleaning; one 8- to 10-volt motor-generator set, 200 to 400 amperes capacity, or some other source of direct current such as storage batteries for plating; one or more 1/4-horsepower alternating-current motors for the stirring device; one or more reducing gears for the stirring device; and the necessary ammeters, voltmeters, crocks, heating coils, rheostats, switches, wire, tools, etc.

In Fig. 1 is shown a set-up that is suitable for building up small shafts. It is provided with four six-gallon crocks. This equipment can be used to build up four shafts at one time, and for ordinary repair work is capable of recovering eight shafts in a day. The equipment consists of a motor-generator set and a switchboard (located under the table); resistance tubes *A* for controlling the current to the individual pieces being plated; electric heaters which are placed inside the crocks; rheostats *B* for controlling the temperature of the plating baths; constant-level bottles *C*, which compensate for any evaporation that may occur over night; and a large pan *D* which collects any solution that may slop over the sides of the crocks. The anodes *E* are attached to the metal strips *F*, and are raised by elevating the supporting beam *G*.

Examples of Built-up Work

The extent to which it is possible to build up a metal surface by the electro-deposition of iron is illustrated by the view at *A*, Fig. 2. The larger section of this piece was formed by the electro-deposition of iron to a depth of one inch on the small rod that projects from one end.

At *B* is shown a small shaft from a drilling machine motor. This shaft was removed from the motor and the bearing surfaces ground to simulate wear. The ground surfaces were then built up by electro-deposition, reground to their original size, and put back in the motor. After eight months of service, the shaft was again taken out and the bearing surfaces measured to determine the wearing qualities of the built-up metal. It was found that the amount of wear was 0.0002 inch, which was the same as that noted in the case of shafts not built up that were operated under the same conditions.

The rod shown at *C* was used in a test to determine the adherence of the electro-deposited iron. This test rod has 0.010 inch of deposited iron on a side, and was bent to a right angle in one direction, straightened and bent to a right angle in the opposite direction without any signs of cracking or breaking away of the deposited iron from the test rod.

* * *

ANNEALING SHEET-METAL PARTS

By A. EYLES

Sheet-metal parts are subjected to annealing processes to soften the metal after the part has been put through operations which have hardened it. It frequently happens that the metal must be annealed two or three times before a given shape can be obtained. The part is worked to a certain stage, annealed, worked to a further stage, and annealed again. If sheet metal cracks or splits in producing parts, it is an indication of lack of annealing and injudicious workmanship. It is always advisable to anneal the metal often rather than to risk fracturing it before the shaping operation has been completed. The process of annealing opens the grain of the metal and relieves the strains and stresses that would otherwise rupture it.

Correct annealing is dependent upon two factors—time and temperature. Varying the length of the annealing period often has a more important bearing on the properties of sheet-metal parts than the temperature has. Sheet aluminum can be most efficiently annealed in a muffle furnace, where the heat is obtained by radiation. The correct annealing temperature for this metal varies between 700 and 900 degrees F., according to the gage of the metal and the length of time that it is subjected to the heat. Ample time should be allowed to obtain an equalized temperature throughout; a sustained heat-treatment at a low temperature gives far better results than a quick operation at higher temperatures. Cooling should take place as slowly as possible. In some cases excellent results have been obtained by immersing aluminum sheet-metal work in a bath of heated oil. (For further information on annealing aluminum, see August, 1921, MACHINERY.)

Annealing and Cleaning Brass Parts

Effective annealing of brass depends much on its composition; but when this is known, satisfactory annealing is obtainable. For instance, 1200 degrees F. may be taken as the correct annealing temperature for sheet brass containing approximately 70 per cent copper and 30 per cent zinc, whereas 1050 degrees F. will be found a suitable temperature for annealing sheet brass containing approximately 60 per cent copper and 40 per cent zinc. The most efficient method of annealing sheet brass is to employ a muffle furnace; however, small pieces may be effectively handled in a smith's hearth by heating them, say, for half an hour and upward, according to the gage of the metal, to a suitable temperature. The parts should be contained in a steel-plate box about 1/4 inch thick, provided with a lid. The fire should be well built round the receptacle. This method is preferable to the much-too-frequent one of simply heating by means of a fire or blowpipe. Such heating usually takes only a few minutes, but it is difficult to heat the part uniformly throughout.

Brass must not be heated above a dull red color, and with the exception of Muntz metal, cannot be worked hot. It must be handled gently while hot, as it will easily crack. Consequently handling sheet brass at a slightly higher temperature than usual must be carefully avoided. When hard-worked or hardened sheet brass, such as is generally used for intricate lamp stampings and spun parts, cannot be annealed by heating to a dull red heat and then plunging immediately in cold water, it can invariably be annealed by heating and allowing the work to cool gradually to the ordinary temperature. Annealed brass parts may be easily cleaned by immersing them in a pickling bath composed of one part of sulphuric acid to ten parts of water. This solution should be kept at a temperature of from 100 to 140 degrees F., and the work allowed to remain in it for about ten minutes. The parts should then be removed and immersed in clean water to remove all traces of the acid solution, and afterward dried in hot clean sawdust.

Annealing Copper Parts

Copper parts should never be annealed in a freshly made coke fire; the blast should first be turned on until the fire is incandescent, as otherwise the sulphur in the coke will ruin the copper. Certain atmospheric gases have also a harmful effect on this metal. Copper sheets can be annealed most satisfactorily by heating them to a red heat of from 1200 to 1300 degrees F., and cooling.

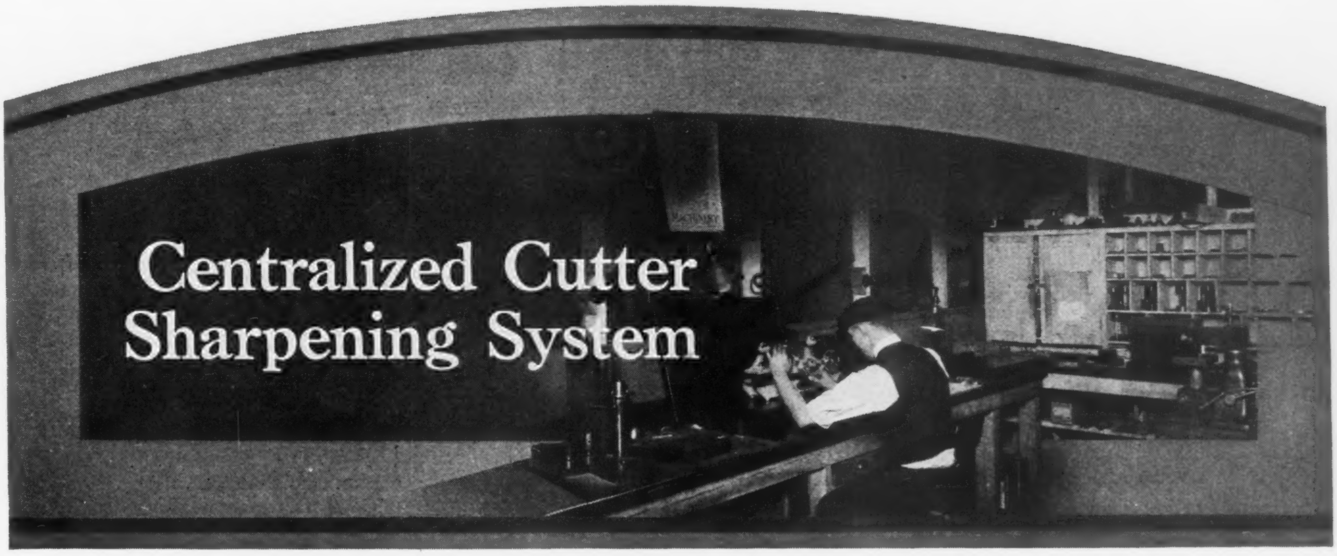
The real danger in annealing copper lies in prolonged heating. The longer copper remains under heat, the greater the effect of damaging gases, whereas heating copper to any temperature short of blistering the surface has little ill effect on it. When copper is heated to the brazing point, or at an even lower temperature for a long period, a transformation appears to take place and the metal becomes brittle, and worthless for smithing. To obtain the best results, it is necessary to have the temperature as high as possible without blistering the surface, and quenching should not be done until the part is uniformly heated.

Mild Steel, Iron, Zinc, and Duralumin Parts

Mild steel and iron sheet-metal parts may be heated to a bright red color to advantage and worked hot, but should not be cooled in water. This simple process softens the metal and makes it more malleable and easier to work. Zinc need only be heated to a temperature of about 300 degrees F.; in fact, sheet zinc is most workable when at a temperature a little above that of boiling water. Therefore, instead of attempting to anneal zinc, it is preferable simply to warm it in order to render it more malleable. Duralumin can be annealed at a temperature of from 650 to 700 degrees F., and quenched in cold water or cooled gradually in the atmosphere. If several operations are to be performed on sheets of this alloy, it is necessary to anneal between the operations precisely the same as with brass, and the work should be performed immediately after quenching as otherwise it becomes too hard for intricate working.

* * *

According to a statement in *Commerce Reports* a strong prejudice exists in Great Britain against any other type of ignition than that using the magneto. Practically all British automobile manufacturers equip their cars in this way, although the new Rolls-Royce 30-horsepower, six-cylinder car is provided with both battery and magneto ignition. American manufacturers exporting to Great Britain usually equip their cars with magneto ignition to meet the demand of this market.



A System for Keeping Machines Supplied with Sharp Tools, Developed at the Plant of the Willys-Overland Co.

By CHARLES O. HERB

THE best results can be obtained in machining operations only when the equipment is in first-class condition. Generally the machines function satisfactorily enough, but tools and cutters are frequently employed after they have become too dull to remove metal efficiently. Instead of using tools and cutters up to the point where resharpening is absolutely essential, they should be replaced by sharp ones just as soon as they cease to render maximum service. In large manufacturing plants the problem of keeping each machine in the many departments supplied with sharp tools is sometimes a difficult one.

In the plant of the Willys-Overland Co., Toledo, Ohio, it was formerly the practice to have each department resharpen all the tools used in that department. However, as the prime interest of the departments naturally was to keep up with production schedules, insufficient attention was paid to tool and cutter grinding. Under the old system, three or four men sharpened all the tools in a department, and so handled a considerable variety, the result being that they did not become specialists on any one class, as they would have been had one man reground only drills, for instance, and another only circular forming tools. Another disadvantage of this system was that the individual machines were not always supplied promptly with sharp tools. A third disadvantage lay in the fact that it was impossible, because of the expense, to furnish each department with the means necessary for accurately inspecting every resharpened tool before sending it back to the machine for use. After carefully weighing the disadvantages of the existing system and the improvements believed possible by instituting a system in which the tools for all departments would be resharpened in one central grinding room, the system described in this article was installed, with highly satisfactory results. An outstanding feature of this system is the small amount of clerical work and supervision required.

Fig. 1. A Row of Shelves containing Special Tools, showing Method of storing Supplies

Inspection of New Cutters, Gages, Fixtures, and Similar Tooling Equipment

In the improved system all new tools, cutters, gages, jigs, and fixtures, before being sent to their respective departments for use, are given a thorough inspection. This holds true both for standard tools bought in the market, and for special tools and fixtures built to specifications by outside concerns or in the tool-room of the plant. In this inspection, all tools are tested for accuracy of dimensions, hardness, and general workmanship. If they are found unsatisfactory, they are returned to the maker for replacement. This department is provided with surface plates, gages, a set of Johansson gage-blocks, a Davies amplifying gage, and other equipment necessary for complete inspection. One corner of the inspection room is shown in the heading illustration. The man sitting at the bench is engaged in testing the accuracy of a Landis die chaser with a West & Dodge lead-testing machine. The service rendered by this department will be appreciated when it is mentioned that as many as 400 parts have been rejected in a month, with an estimated saving of approximately $1500.

From the inspection room all tools

Fig. 2. General View of a Departmental Tool-crib

and other parts that have been found satisfactory are sent to a store-room which is divided into two sections known as "Stores A" and "Stores B," respectively. The standard tools that have been purchased from manufacturers' catalogues are kept in Stores A, while the special tools, fixtures, gages, etc., bought according to blueprints and specifications are carried in Stores B. A perpetual inventory is kept of all the tools and cutters in Stores A, and a maximum and minimum supply is specified for each type and size. When the supply for a particular part is reduced to the minimum, more parts are ordered. Ninety days is usually figured on as the required time between the date parts are ordered and the date they arrive at the store-room after having been inspected.

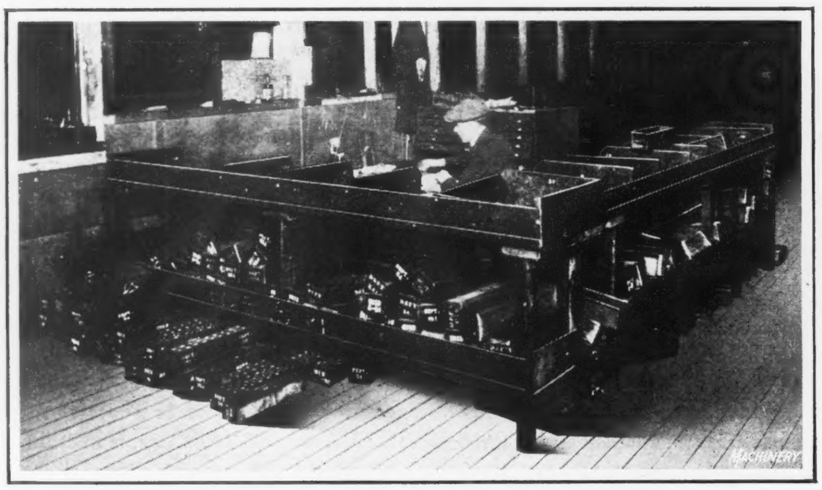


Fig. 3. Receiving Bench in the Resharpening Department

Stores B include all special tools and cutters, even though they may be standard except for a slight difference in diameter or length, and all jigs, fixtures, gages, and similar tooling equipment. The reserve supply of parts in Stores B is lower than is the case in Stores A. The reason for this is that in the event that the tooling for a given job is altered, some of the special parts used in the original tooling may be dispensed with. Again, if there is no similar set-up in the shop, it may be necessary to discard these special tools, and in such an instance, the smaller the supply, the less the tool loss. On the other hand, the parts in Stores A, being standard, can always be used.

The supplies in both divisions of the store-room are packed in long metal boxes when their size permits, and these boxes are stored on shelves, as illustrated in Fig. 1, which shows a section of Stores B. Other cumbersome parts, such as die-stocks, chucks, and fixtures are placed directly on the shelves, as shown. From Stores A and B parts are distributed to tool-cribs located about the plant, a tool-crib usually being provided for each department, although some cribs serve two or three small departments. The men in charge of the department tool-cribs make out requisitions to give the clerks in Stores A and B authority to release parts from stock. The entire clerical work in this system consists only of ordering new parts for Stores A and B as the supplies run low, keeping inventories of the parts in stock, and requisitioning parts from stock.

Function of the Tool-cribs

In order to obtain maximum efficiency from all tools and cutters, the tool engineering department determines upon the maximum number of parts that the cutters of every machine shall produce before they are replaced. When the predetermined number of pieces has been reached, the operator brings his set of cutters to the tool-crib and receives a sharp set in return. The dull cutters are placed in a metal receptacle, on which is stencilled the number of the tool-crib, to await transportation to the sharpening department. There is an hourly truck delivery service to and from each tool-crib. As the truck-driver calls at the crib, he delivers sharp cutters and takes away dull ones for resharpening, the latter being kept in the container in which the crib attendant placed them in order to afford ready recognition. The tool-crib also functions in the ordinary manner to keep machine operators supplied with tools and attachments that are but occasionally used. The attendant keeps a record of the tooling requirements for each job going through the department and decides when a cutter has been worn beyond the point where resharpening is possible. Fig. 2 shows a typical tool-crib in this plant.

The truck-driver delivers all dull tools and cutters to the receiving desk of the resharpening department, illustrated in Fig. 3, where the clerk places the tools in bins, according to the department from which they came. The different bins have the department numbers stencilled on them. This clerk also distributes the cutters to the various machines for resharpening, his particular duty being to see that all men are kept supplied with work. If the tools are of a type that require a special set-up, they are held in the binds until a sufficient number are on hand to warrant making the set-up. This means that in some cases four or five sets

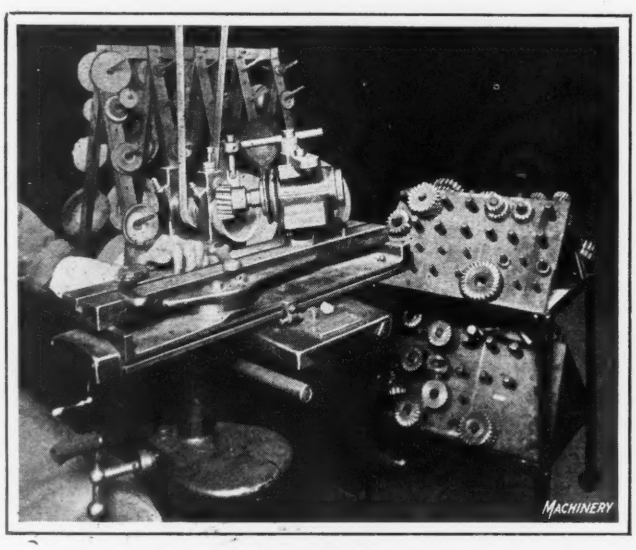


Fig. 4. Chamfering the Cutting Edges of an End-mill on a Cutter Grinding Machine

of cutters are distributed between the resharpening department, the tool-crib, and the machine on which the cutters are employed.

The resharpening department is well equipped, having approximately 65 grinding machines of various types and makes, including universal, tap, broach, drill, and cutter grinding machines. There is also equipment for reconditioning grinding wheels, for use both in this department and in the manufacturing departments. The number of employes in this department averages sixty-five; and the number of tools resharpened per day of nine hours averages 3000.

Each cutter grinding machine is provided with a rack of the type illustrated in Fig. 4, having pegs on which cutters are placed before and after sharpening. An operation of interest is presented in Fig. 5, which shows an operator backing off the cutting edges of a taper spiral reamer. The operator feeds the table with one hand, at the same time turning the reamer on its centers with the other hand, so as to keep the face of the cutting edge that is directly in back of the one being ground in contact with a tooth-rest extending down from the top of the wheel-head. A universal grinding machine is shown in Fig. 7 employed in a cylindrical grinding operation on a broach used for producing 0.563-inch holes within a tolerance of 0.0005 inch.

The operators of the various cutter grinding machines return the sets of ground cutters to the clerk in charge of the receiving bench, who again places them in the proper departmental metal boxes and passes them through the window, shown at the left in Fig. 3, to an inspector on the other side. Drills, reamers, and similar parts are placed in holes in wooden blocks, so as to prevent damage to the edges. A pile of these blocks is shown before the window in the illustration Fig. 3.

Fig. 5. Backing off the Cutting Edges of a Taper Spiral Reamer

One of the principal advantages of this centralized sharpening department is that one operator can be kept continuously on drills, for example, another on broaches, another on milling cutters, etc., with the result that he becomes specialized on one class of tools and regrinds them much more satisfactorily than was possible with the old system under which one man handled a variety of cutters. Another advantage of keeping one man on a certain class of work, is that in cases where tools are spoiled in sharpening, the blame can be readily placed where it belongs.

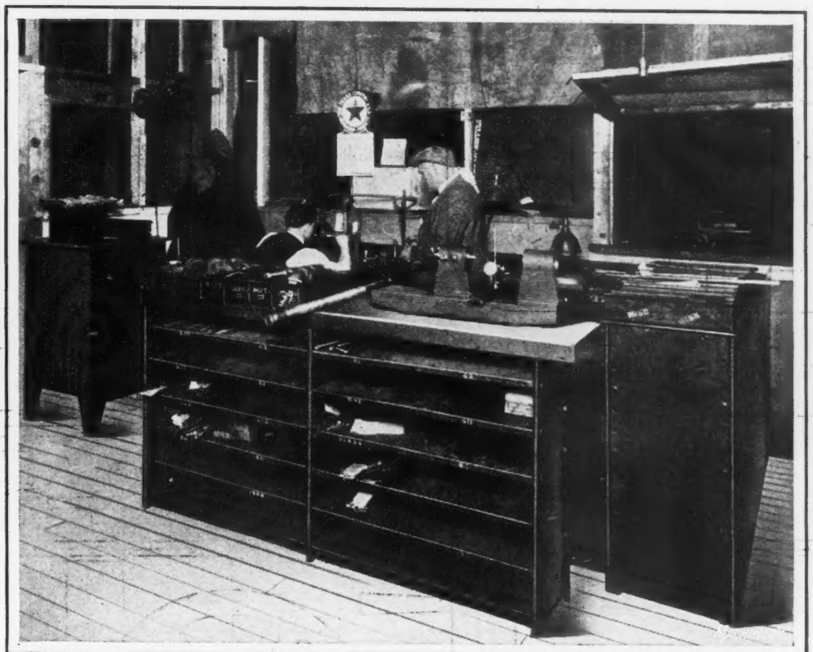


Fig. 6. Bench at which all Resharpened Cutters are inspected

A view from the opposite side of the window in Fig. 3, is presented in Fig. 6. Here all sharpened cutters are inspected prior to delivering them to their respective tool-cribs. The inspector is provided with a surface plate, micrometers, dial indicators of various types, an amplifying gage, a scleroscope, and other equipment necessary for determining the accuracy of the tools. As he receives the cutters through the window, he inspects them and places them either in containers, stencilled with the number of the department to which they belong, or else directly on the shelves shown in the foreground of the illustration, which are also stencilled with the numbers of the various departments. The containers are kept on the top of the tier of shelves, as shown. When the tool truck-driver makes his hourly call at the receiving bench of the department, he removes from the inspector's shelves the resharpened tools that have been found satisfactory. These are delivered to the tool-cribs on his next trip through the plant. Two trucks are required to maintain this service.

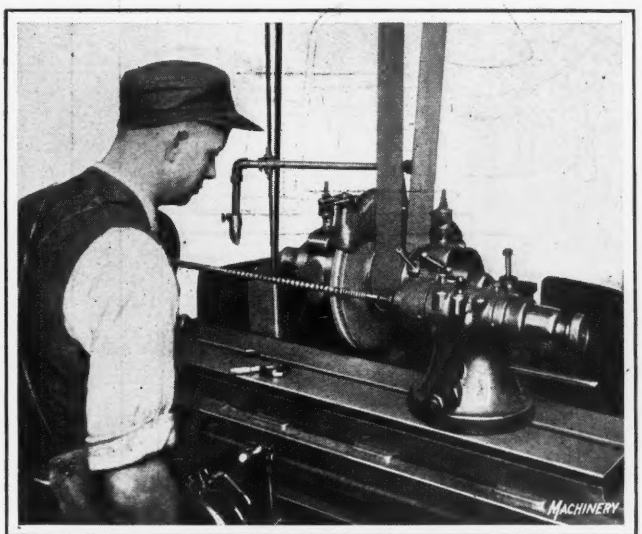


Fig. 7. Cylindrical Grinding Operation on a Broach

* * *

Japan's total imports from the United States in 1922 amounted to $298,084,745, of which $28,655,397 represented machinery and parts. Imports of machinery amounted to $2,343,162 in May, 1923, falling off to $1,860,000 in July.

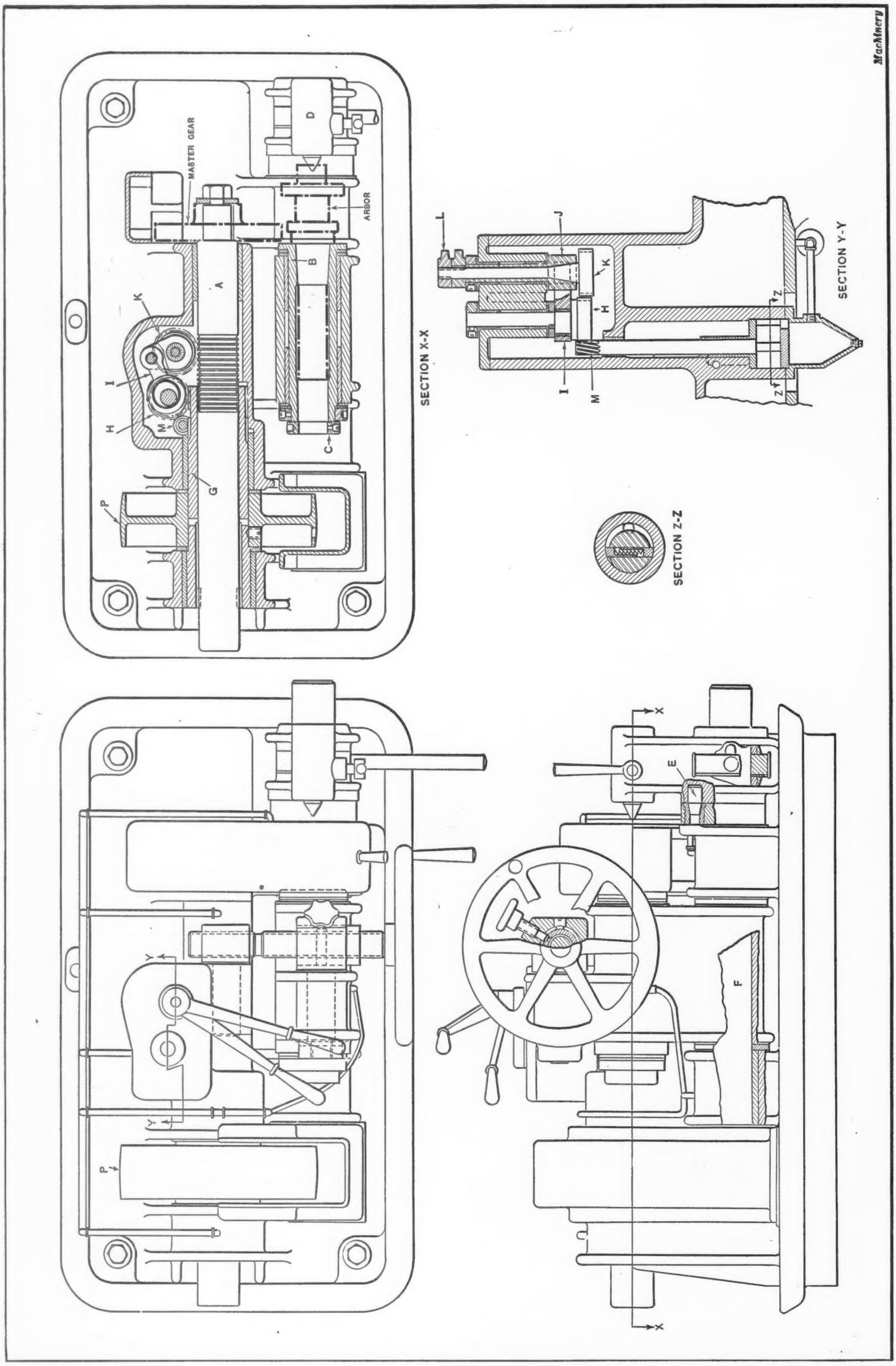


Fig. 1. Special Machine developed for eliminating Imperfections in the Teeth of Automobile Transmission and Timing Gears by rolling them with a Master Gear

Accurate Manufacture of Automobile Gears

By A. B. BASSOFF

NOISY operation of gears is attributed to imperfect action of the teeth, which results from such defects as eccentricity and irregularity of the pitch circle and inaccuracies in the tooth profiles. In an endeavor to eliminate these imperfections in automobile timing and transmission gears, a method was adopted in one automobile plant by means of which practically faultless gears are now being manufactured on a production basis. The tooth profiles of the gears produced by this method are extremely accurate and the pitch circle is concentric within very close limits. In the following, the various steps in the manufacturing process will be outlined and the special machines employed will be described in detail.

Manufacturing Procedure

The first step in the manufacture of the gears is to rough- and finish-turn the blank and grind either the bore or the stem, depending upon the design of the gear, for locating purposes. The gear teeth are then rough- and finish-machined on a gear generator on which the blanks are located by means of the surface ground in the preceding step. The tooth thicknesses are left from 0.001 to 0.002 inch over size, this excess metal being removed in the third step, which consists of rolling the teeth with those of a master gear in a machine especially designed for the purpose. After the rolling operation the gears are heat-treated and then in the case of timing gears the teeth are lapped in another special machine. In the next step the teeth are machine-tested while the final step consists of a dynamometer test. The latter test is used only in connection with timing gears.

Gear-tooth Rolling Machine

In Fig. 1 is illustrated the rolling machine employed to impart the correct profile to the teeth and to generate a true pitch circle concentric with the gear center. The machine is driven by belt through pulley *P*. As mentioned in the

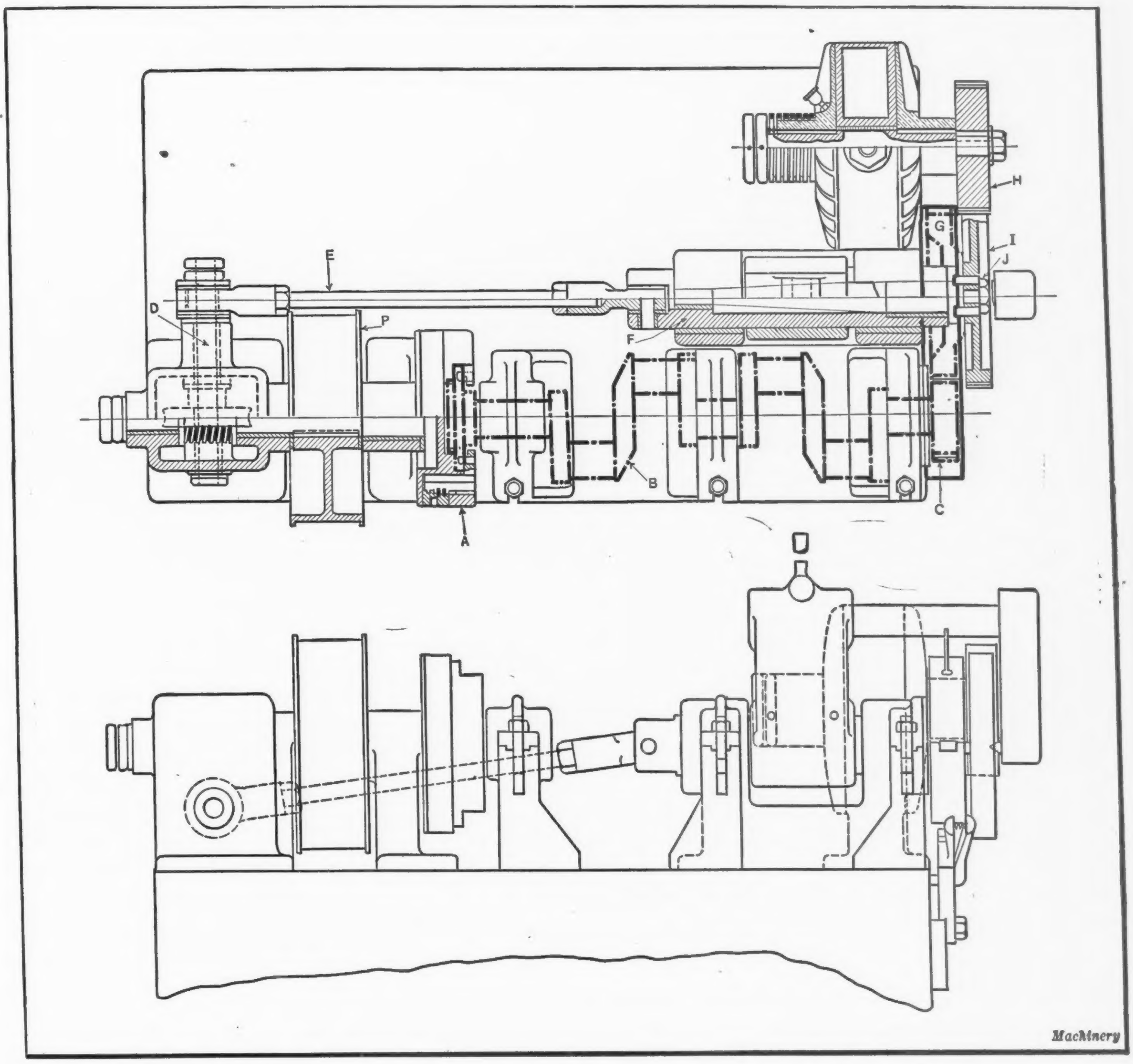


Fig. 2. Machine in which Timing Gears are lapped by rubbing the Teeth of Two Gears together with an Abrasive

foregoing, the thickness of the teeth is reduced in this operation. The master gear with which the gear being rolled is meshed is mounted on the main spindle *A*, shown in section *x–x*. This spindle is keyed to the driving sleeve *G*, and rotates with the driving pulley. The master gear is hardened, ground, and lapped all over in gears of the spur type; but, with helical gears, the master gear is not lapped.

The work is held on an arbor clamped tight in the running sleeve *B* by means of the clamping nut *C*. The other end of the arbor is supported on the spring center of tailstock *D*, this center being provided with a locking device which holds it in place after it has been located in the center of the work-arbor. From the front view of the machine it will be noted that the tailstock is provided with a cam-ring and held in alignment by means of a taper pin *E*. By

Wear on the master gear is equalized across the entire face width by reciprocating shaft *A* so as to bring all parts of the teeth on the master gear to bear on those of the work. From section *x–x* it will be noted that the driving sleeve *G* has two integral spiral gears. The front one of these meshes with a gear at right angles to it, which is shown in section *Y–Y* at *H*. The stem of the latter is provided with a cylindrical surface cut eccentrically with reference to the center line of the stem, which produces a crank motion on connecting-rod *I* as the gear revolves. This connecting-rod joins the eccentric to a swiveling sleeve *J* in which gear *K* is held by being drawn against a taper seat in sleeve *J* through the medium of lever *L*. Gear *K* meshes with a circular rack cut on the main shaft, and, reciprocates the latter and the master gear as sleeve *J* is swiveled by the

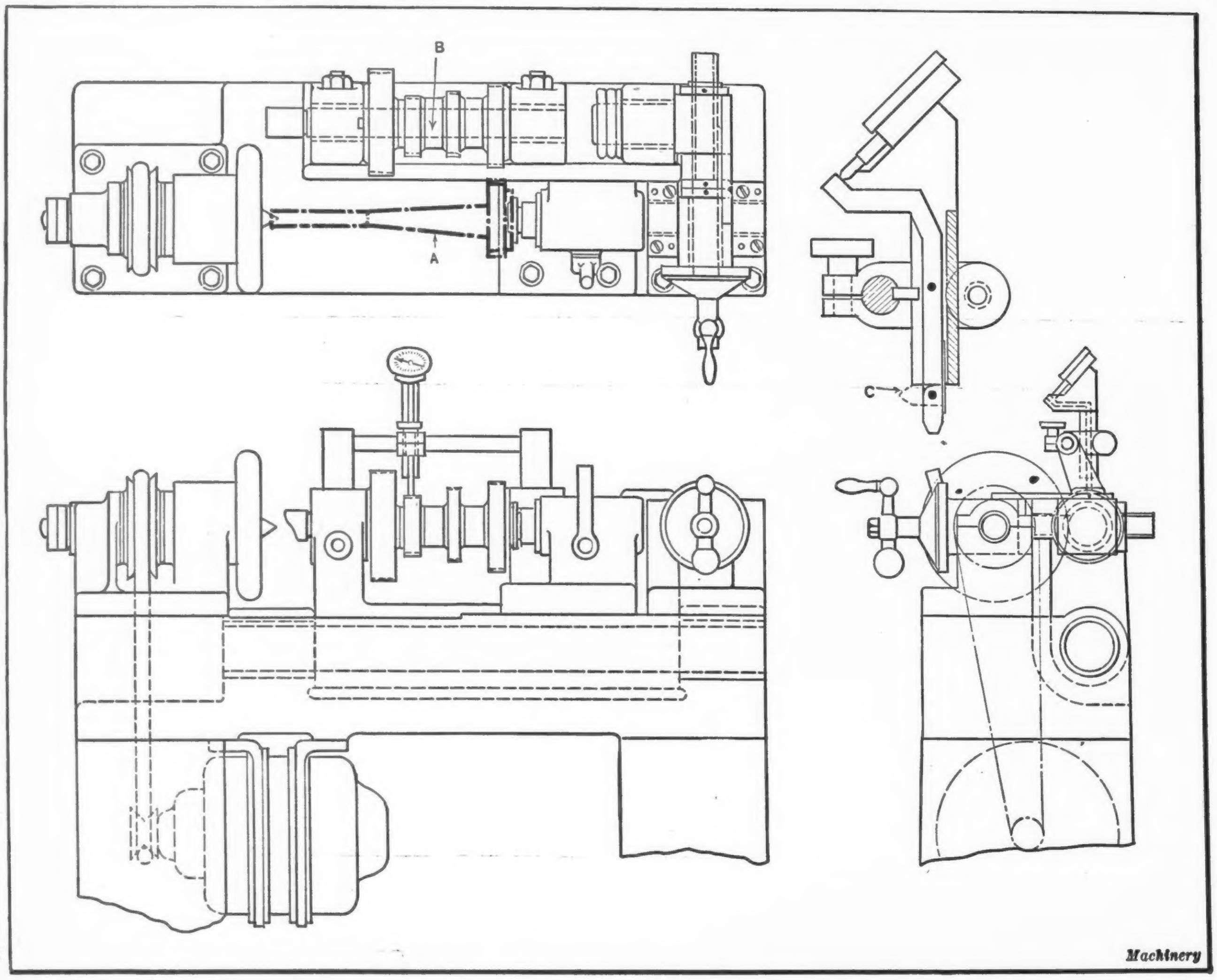


Fig. 3. Machine employed to test the Pitch Diameter, Concentricity of Pitch Circle, Amount of Backlash, and Quietness of Operation

revolving the cam-ring with the lever provided, it is possible to withdraw the tailstock from the arbor and swing it out of the way to facilitate the removal and insertion of arbors.

The bracket in which sleeve *B* is held is keyed to a large shaft *F* on which the tailstock is also mounted. It is possible to swing this bracket, the gear to be rolled, and the tailstock as a unit to or from the master gear. In the actual rolling of the gear, this unit is moved toward the master gear by means of a differential screw fitting into two nuts which swivel in their bearings. This mechanism is shown in the plan view. The differential action of the screw allows great pressure to be exerted on the gears with a relatively small movement of the swinging bracket. For quick action, when altering the center distance between the bracket and the master gear, the nut in the bracket is provided with a sleeve, by loosening which and holding the differential screw stationary, it is possible to move relatively large distances without differential action.

eccentric. Adjustment of the main shaft can be made without affecting the reciprocating mechanism by loosening the upper lever *L*.

Owing to the high pressure used and the close fit of the bearings, a positive pressure system of lubrication is provided. A section through the pump of this system is shown at *Z–Z*. This pump is driven from the main driving sleeve through the second integral spiral gear which meshes with gear *M* shown in sections *X–X* and *Y–Y*. The entire machine is reversible so that both profiles of the gear teeth can be rolled at one setting. Guards are provided at all necessary points to protect the operator. The guard that covers the master gear is supplied with an oil-pipe so that a stream of lubricant may be constantly directed on the gear faces. It will be noted that the work-arbor has a long bearing in the running sleeve and that the main shaft is also provided with long bearings. This design insures parallelism of the tooth faces of the work and the master gear.

Concentricity of the pitch circle is insured by rolling the gear against a true master gear in generating it. The accuracy of the tooth profiles, it is evident, depends upon the accuracy of the profiles on the master gear, and so extreme care is taken in making the master gear to insure that the profiles are exact. This machine is suitable for spur and helical gears, but it is not practical to design it for too great a range in size. For the class of work with which this article deals, however, a single machine will take care of the entire range.

Construction of the Lapping Machine

Slight imperfections that may remain in the timing gears after the heat-treatment are removed by the use of the machine shown in Fig. 2. Two gears are placed on this machine at a time, and immersed in an abrasive, the teeth of one gear being rubbed across those of the other by a reciprocating movement. To increase the abrasive action, a load that maintains a constant pressure on the tooth profiles is placed on the gears. The drive is transmitted from a lineshaft to pulley *P* which is keyed to the main driving shaft. Chuck *A*, attached to the driving shaft, holds a dummy crankshaft *B*, on one end of which the crankshaft gear *C* is mounted. It was decided to use a dummy crankshaft in preference to other means in order to reproduce as nearly as possible the conditions under which the gears must work in use.

The chuck jaws are moved in a direction parallel to the center line of the chuck. The crankshaft is held rigidly endwise between the chuck jaws and the chuck body, and is driven by means of pins in the chuck jaws which fit corresponding holes in the flange of the crankshaft. The movement of the jaws is controlled by an internally threaded ring which may be seen in the plan view. The crankshaft fits in three bearings that correspond to the bearings of the crankcase in which the crankshaft is regularly assembled. A felt ring is provided at the front end of the crankshaft close to the place where the gear is mounted, to prevent abrasive from reaching the bearings. All bearings and the felt ring are split to facilitate the removal of the crankshaft.

A worm keyed to the left-hand end of the driving shaft meshes with a worm-wheel mounted on shaft *D*, which is located beneath the driving shaft. An eccentric near the back end of shaft *D* transmits a reciprocating movement to sleeve *F* through connecting-rod *E*. Sleeve *F* contains bearings which accommodate an arbor on which the large timing gear *G* is mounted, while the lapping operation is in process. A felt ring is also supplied here to prevent abrasive from reaching the bearing surfaces of the arbor. From the front view it will be noted that a bracket is keyed to the sliding sleeve *F*, and this bracket carries, at its upper end, an overhanging arm and a center, the construction of which is similar to the over-arm of a milling machine. The purpose of this over-arm is to support the outer end of the work-arbor. A cast-iron drum attached to the rear end of the machine is provided with bronze friction disks keyed to the shaft that runs through the drum. These disks are held in place by the pressure of a spring, and furnish the load on the gear teeth necessary to obtain the proper abrasive action, the load being transmitted to gear *G* through gears *H* and *I*. The drum is water-cooled.

In using this machine, the operator places a crankshaft gear on the dummy crankshaft and secures the latter in place in the split bearings and chuck. A timing gear is then mounted on the special arbor and gear *I* is placed over it, pins in gear *I* engaging holes in the timing gear and the arbor. This unit is then clamped by means of nut *J* and inserted in sleeve *F*. The trough containing the abrasive compound is next raised, and the hinged cover is swung over the gears to be lapped so as to enclose the latter completely. The overhanging arm is then swung down to hold the arbor securely endwise, and is clamped by means of the lever above it. When power is turned on, the gears carry the abrasive compound on their teeth, and these are lapped by the reciprocating action of the sliding sleeve and the load on the teeth. This machine was designed to take care of timing gears only.

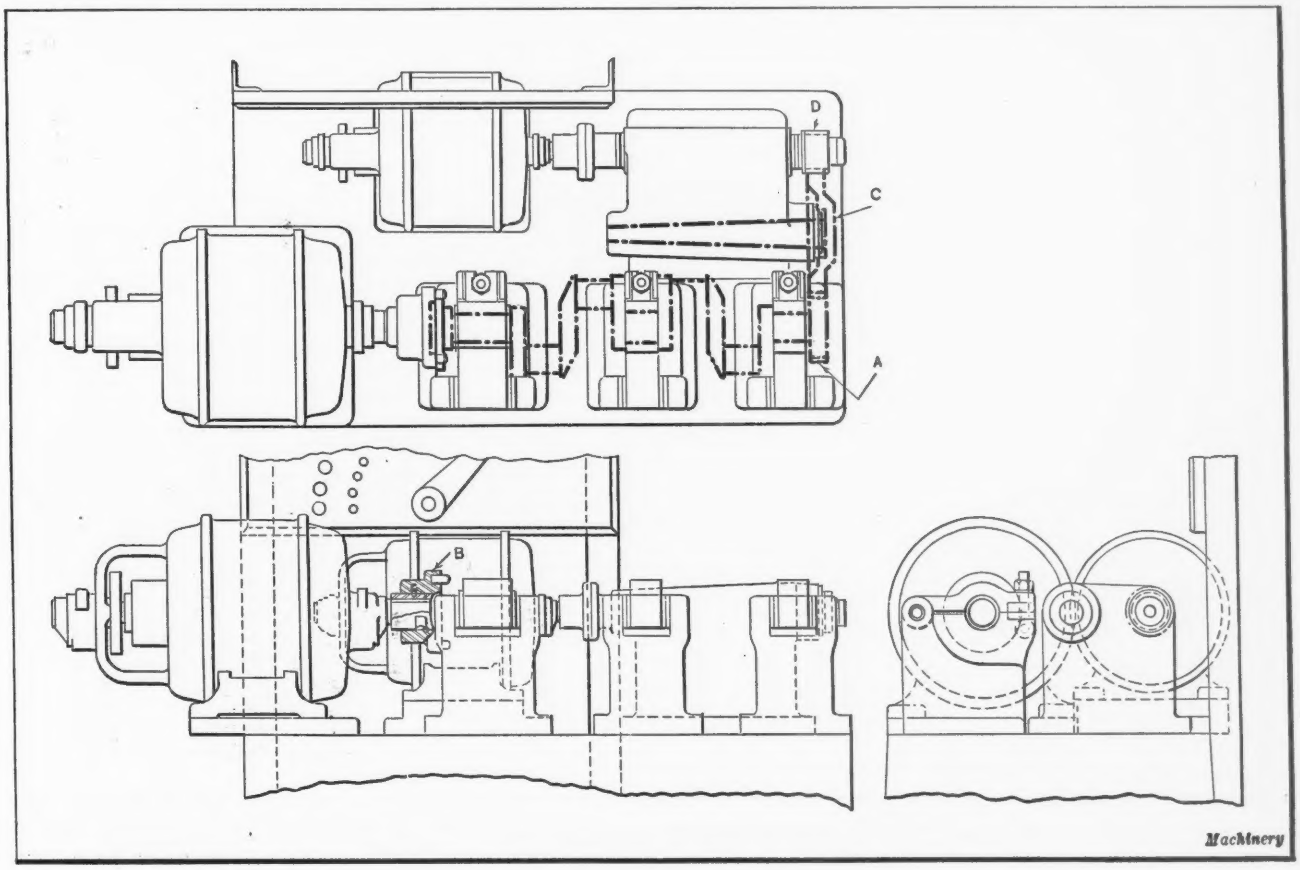


Fig. 4. Test Stand used to detect Defects in Timing Gears after they have been assembled

Machine for Testing Gears

The machine designed for testing the gears for correctness of pitch diameter, concentricity of pitch circle, amount of backlash, and quietness of operation, is shown in Fig. 3. The gear to be tested is mounted on an arbor *A* which is placed between centers, as shown in the plan view. The tailstock center is of the spring type, which is clamped after the arbor is in place. The headstock has a live center, and the work is driven by the use of a standard lathe dog that fits a hole in the faceplate. Ground and lapped master gears are placed on arbor *B*, which is clamped in a swinging bracket located at the rear of the machine. The bracket is adjusted by means of a screw that engages a swiveling nut in the bracket. A dial at the front end of the screw is graduated to read to 0.0001 inch.

After the gear has been brought into mesh with one of the master gears, the screw is set at the proper center distance and the teeth are tested for backlash. This is done by the use of a dial gage mounted at an angle on the top of a vertically adjustable tube which is secured in a bracket that slides on a round bar over the master gears. The tube to which the dial gage is attached contains a swiveling lever, at the lower end of which is mounted a rack tooth of the same pitch as the gear teeth being tested. By holding the work stationary and moving the master gear, it is possible to test the amount of backlash by means of the dial gage. The backlash test serves also to test the concentricity of the pitch circle because any variation in the backlash is due to eccentricity or irregularity of the pitch circle. At a given center distance, a certain backlash should exist, and this determines the correctness of the pitch diameter. The gear is thereafter tested for quietness by allowing it to run in mesh with the master gear for a short period at a certain speed.

Provision is made against damaging the accurately made rack tooth of the gage by accidentally starting the speed test before the tooth is removed from the master gear. This is accomplished by having the tooth attached in such a way to the swiveling lever that if the motor is accidentally started, the rack tooth will double against a spring, in a manner similar to the closing action of the blade of a pocket knife. The tooth is shown in the closed position by the dotted lines at *C*; it will remain in position above the master gear and have no tendency to jar back while the machine is in operation. The usual method is to lift the entire gage clear of the master gear prior to the running test. All parts subject to wear are hardened and ground, and those requiring it are lapped. The screw for setting the arbors to the correct center distance was made with great accuracy, and tests have proved the total variation of lead in 6 inches to be only two hundred-thousandths inch. The accuracy of the nut corresponds to that of the screw.

Testing for Silent Running after Assembling on Shafts

The test stand shown in Fig. 4 is used in a "silence" room for the purpose of detecting defects in timing gears after they have been assembled on their respective shafts preparatory to being assembled in the crankcase. The crankshaft, shown by heavy dot-and-dash lines in the plan view, which carries gear *A* at the outer end, is clamped in split bearings in a manner similar to that employed in the lapping machine. The crankshaft is driven directly from a motor through chuck *B* which is provided with pins that engage holes in the crankshaft flange. The arbor for timing gear *C* is inserted in bearings directly behind the crankshaft. A shaft carrying a fabric gear *D* which meshes with the timing gear *C* is direct-connected, through a flexible coupling, with a generator. Immediately behind the generator is mounted a vertical panel containing the various controls. The test consists in applying various loads at different speeds in order to detect noisy operation.

MILLING CAMS FOR PRINTING PRESSES

Whenever the machining of cams on an extensive scale is required, as in the manufacture of printing presses, it is often a profitable plan to construct a special machine for milling those cams that are used in large quantities. It may be found in constructing machines for special uses, that the same principles incorporated generally in commercial cam-millers can be applied; or, even, certain units can be taken from standard machines and worked into a single-purpose machine to advantage. In the cam-milling department of the Kelley Press Shop, American Type Founders' Co., Jersey City, N. J., special machines are used in addition to the regular commercial types. Two of these are shown herewith. In their construction, units from other machines have been freely used; the results obtained by handling the work of this department in this way have been very good. Automatic features are employed to the extent that the entire cam-milling machinery in the department (there are from six to eight machines) can be

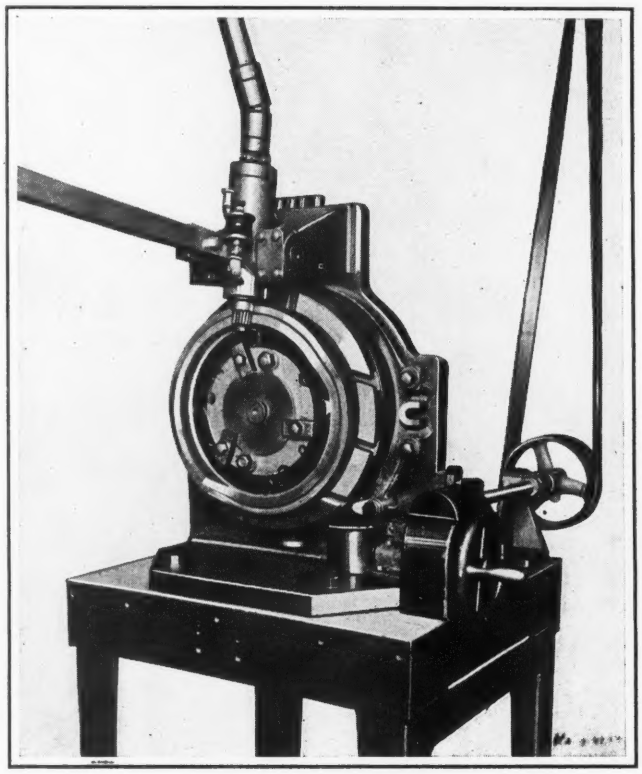


Fig. 1. Single-purpose Cam Milling Machine for Cams of the Side-face Variety

kept in continuous operation by one man—or possibly two at times when the production need be unusually great.

A face-cam in the form of a ring is used to operate the gripper fingers that hold and release the paper as it passes over the cylinder of a Kelley printing press. This cam is called the gripper cam, and within it there is assembled what is known as an impression cam, the function of which is to intermittently raise the cylinder. The gripper cam and many similar face-cams, are milled on the special machine illustrated in Fig. 1. The faceplate of this machine is slotted to accommodate master cams of various diameters, which are held in place as indicated. These master cams or rings locate the work within them before the cams are bolted to the faceplate. The faceplate is driven through a standard worm-wheel feeding mechanism (shown at the right), which can be regulated to give the cam a surface speed corresponding to that of the cam roller.

The cutter shaft is driven from overhead and is of telescopic construction with a universal joint connecting with the spindle of the cutter-head to take care of various sizes and types of cam, and to permit the head to rock on trunnion bearings as the cutter follows the desired contour.

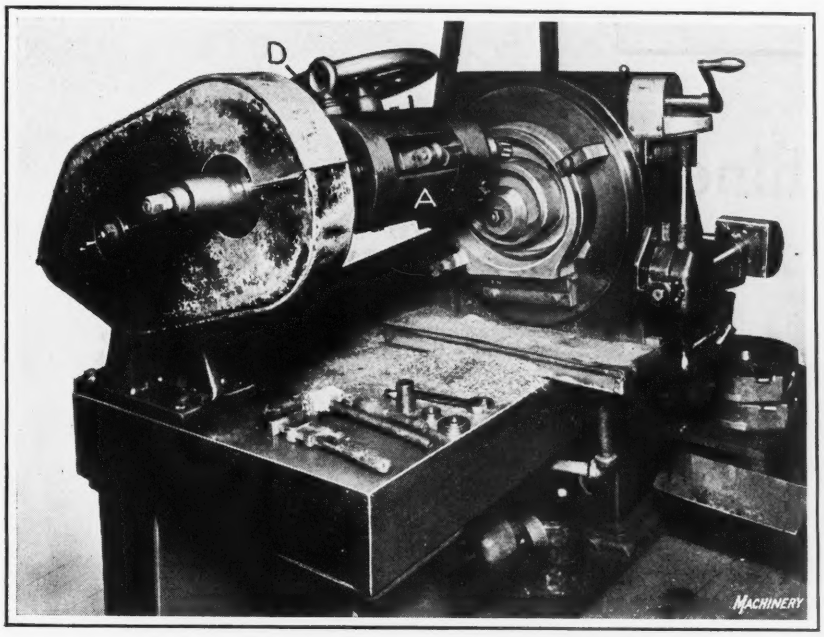


Fig. 2. Cam Milling Machine with Swinging Spindle Frame

The cutter-arbor carries a hardened steel roller just above the face-milling cutter. The roller is kept in contact with the cam surface of the master by a weight on the end of an arm forward from the cutter-head.

Another design of special cam milling machine used in this department is shown in Figs. 2 and 3. The cam shown on the faceplate of the machine in Fig. 2 is a crank cam for governing the traverse of the printing press table. The cutter-spindle, which is a Garvin cam-milling machine unit is carried in a heavy frame *A* which pivots from a bearing at the rear on the drive shaft of the machine, as determined by the master cam. A better illustration of this feature of the machine is that contained in Fig. 3. Here the arm is shown in an elevated position and the cam roller, which is carried on stud *B*, raised from the master cam *C* on which it operates to control the swinging movement of the frame *A*. The feeding device at this corner of the machine is also regular Garvin construction.

The spindle is driven direct from the driving shaft by a belt (shown guarded), and at the completion of the operation the end-mill is withdrawn by operating the handwheel *D* which adjusts the position of the sleeve in which the end-mill is held. To allow for removing the work, the frame is swung upward as shown in Fig. 3, and for this purpose a chain and block are used. The work is previously faced so as to seat evenly on the faceplate, to which it is clamped and on which it is located by a bar attached to the faceplate and a flat surface on the exterior of the cam.

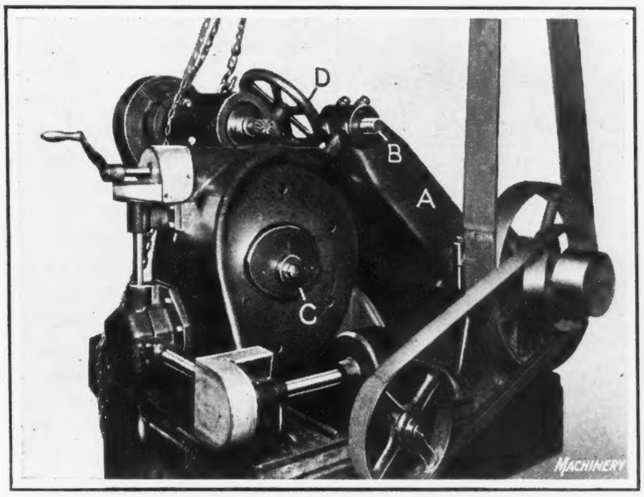


Fig. 3. Cam Milling Machine with Cutter-head in Elevated Position, showing Master Cam and Faceplate Feed Mechanism

NAMES OF PARTS ON DETAIL DRAWINGS

By M. B. DUGGAN

The writer was much interested in the article in June MACHINERY that described the endeavors of the Toledo Machine & Tool Co., to standardize the names of power press parts; it is a splendid idea. It is surprising that in many machine-building plants the majority of patternmakers, foundrymen, and machinists do not know the names of parts on which they are working, and neither do the foremen of the departments. This condition is due to the fact that it is common practice for draftsmen to put only identification numbers and letters on the detail drawings furnished shop men and not to give the names of the individual parts. The name of the machine for which the part is intended is always given, and perhaps the name of the particular unit to which the part belongs, but the name of the part should be given as well. If the men are not familiar with the names of parts, confusion and misunderstandings are frequent when one department desires information from another department regarding a part.

Departmental records should also contain both the name and number of parts as given on blueprints, and then it would be an easy matter to answer from memory many inquiries regarding work in process or completed; blueprints of a job are not ordinarily kept in the shop after the job is finished. If only the number is recorded it is impossible to keep in mind more than a few of the parts. However, if a name appears in the records beside the number of the parts, it is usually easy to recall the features of the part.

Suppose, for instance, that the patterns for a certain part are at the foundry and the foreman molder telephones to the pattern shop for information pertaining to core box No. 4567-1-B. If this number appears in the record book of the pattern shop without the name of the part and a blueprint of the part is not available in the pattern shop, it will be necessary for someone to get in touch with the drafting department before the foundry inquiry can be answered. If the name of the part appears in the records with the number, the question can be intelligently answered without delay. Problems of the pattern storage would also be lessened considerably if records were kept of the names of parts as well as the numbers.

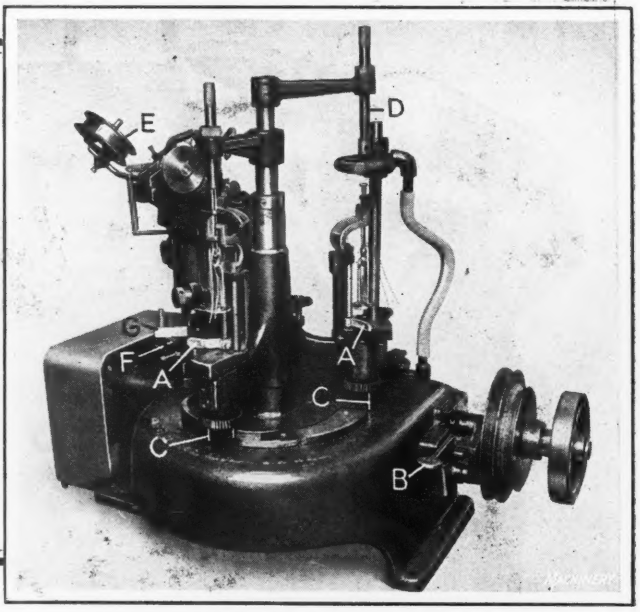
* * *

MANUFACTURE OF PRECISION GAGE-BLOCKS

Considerable progress has been made in England in the manufacture of gages of the Johansson type. The commercial production of these gages is now in the hands of the Pitter Gauge & Precision Tool Co., Ltd., of Woolwich. By reason of the method of production and the simple lapping and measuring apparatus used, a very accurate product is likely to be available before long at prices that appear low in the light of past experience. The aim is to put precision gages within easy reach of every manufacturer—to make it, in fact, cheaper to buy precision gages for continual use than to follow any other method of controlling dimensions. This development will be of the greatest importance, not only to the maker of high-grade products to very close limits, but also to the engineering trades where the wider limits are allowable. It is held that large limits are of little value unless their exact position on the standard scale can be assured.

Automatic Machines in the Electric Lamp Industry

Interesting Mechanisms Employed to Actuate Automatic Lamp Machines



PERHAPS the most interesting and ingeniously designed machine used in the manufacture of incandescent electric lamps is an automatic machine for making the supporting wires for the filament and inserting them in the glass button on the stem. "Inserting machines," as they are called, differ slightly in their construction according to the type of lamp being manufactured. In what is known as the C type electric lamp, these wires are inserted radially in one button only, at the lower end of the stem. They are formed with a curl at the end, known as a "pigtail," and the filament is a coil suspended in a horizontal plane from these pigtail wires. The ends of the filament coil are brought together and welded or clamped to the lead wires which extend up to the base of the lamp and form the connection for the current. The machine for inserting the pigtail wires also makes the glass button.

The B type lamp has two buttons, top and bottom, on the central stem, with radial wires in each and the filament strung in a zigzag fashion between them. This machine does not make the buttons, but it is more complicated than the other because of the necessity of inserting anchor wires in the two buttons which, of course, are at different heights. Also, there is one more anchor wire in the top button than in the lower one, so means must be incorporated in the machine for taking care of the difference in angular spacing.

The first of these machines is shown in the heading illustration. The loading station is at the front, and the glass stem, which previously has been fused to the flare is located, flare down, between spring tension jaws. One of these jaws has two bearing surfaces which are situated about an inch apart, while the other, diametrically opposite, is in an intermediate position between the other two. The jaws are opened and closed by the thumb-lever *A*, the loading occurring at one station while the other two stations are in operation. There is an adjustable stop carried on an arm by the central vertical turret shaft, against which the stem is located to insure that it is at the proper height for making the button.

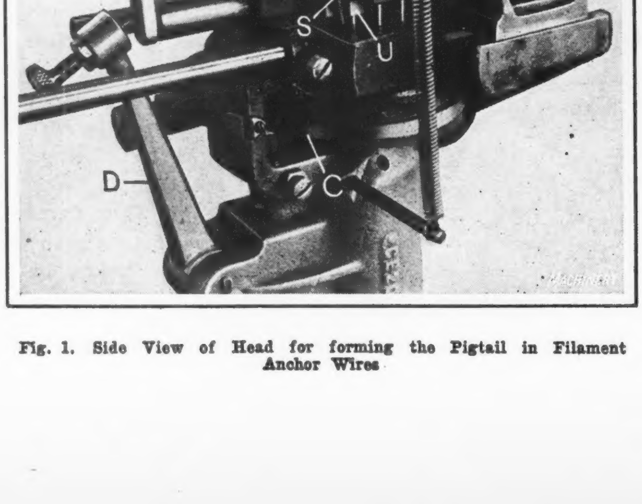


Fig. 1. Side View of Head for forming the Pigtail in Filament Anchor Wires

After one station has been loaded, the starting lever *B* at the right is depressed and the turret revolves to the station where the glass button is formed. Here it is stopped by a lug engaging the worm-wheel that revolves the turret. At the lower end of the work-holder there is a ratchet wheel and two pins, one longer than the other. As the turret revolves to the first station the longer of these two pins, *C*, bears against a strap cam screwed to the base of the machine, which causes the work-holder to turn slightly and brings it into the correct radial position for the insertion of the first pigtail wire by the time the third station of the machine has been reached. The pin becomes free from contact with this cam at the second or button-forming station.

The button is formed by a plunger *D* which is operated vertically from a cam beneath the machine. This plunger passes through the circular burner from which jets of gas flame are directed against the glass. As soon as the glass becomes plastic, the plunger descends and forms the button. During this operation another stem has been loaded at the front of the machine, and when the starting lever is again tripped, the stem on which the button has been formed passes to the station where the pigtail wires are made and inserted. The mechanism, or head, for performing this operation is shown in different positions in Figs. 1, 2, and 3.

The pigtails are made of molybdenum steel wire carried on spool *E* (see heading illustration), and automatically fed, cut off, and formed on the end. Referring to Figs. 1, 2 and 3, which are views from the side and front of the head, the wire passes through a hole in guide *A* and lies in a groove in the side of the brass slide *B*, with its end resting in the lower jaw. All the movements of this head are actuated by a special multiple cam, the design of which is shown in Fig. 4. This cam is located at *C* directly beneath the head. The rise on the under side of the cam forces a plunger downward, pivoting the bellcrank lever *D* (shown clearly in Fig. 1) and advancing rod *E* in the slide until its angular end wedges under the end of hinge-

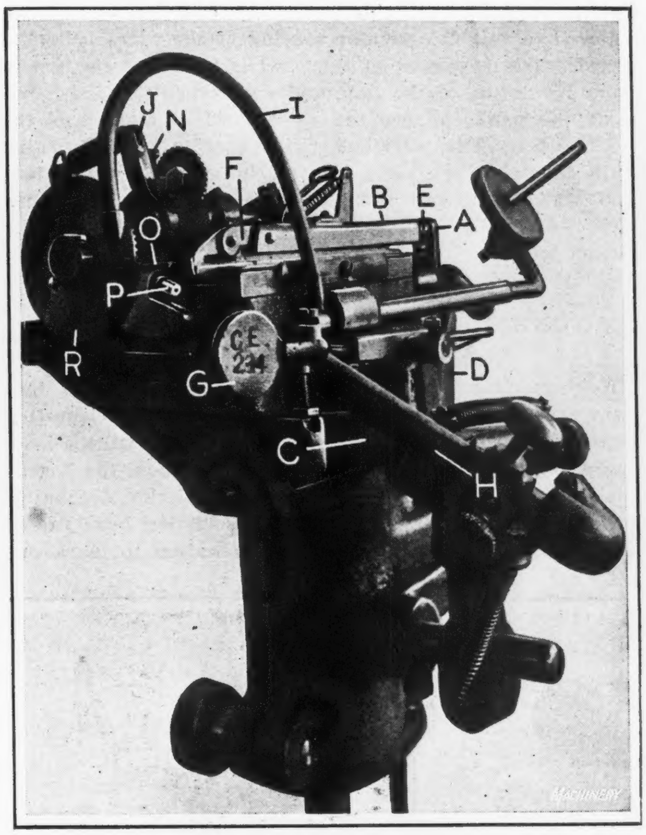


Fig. 2. Front View of the Head with the Cutters Open

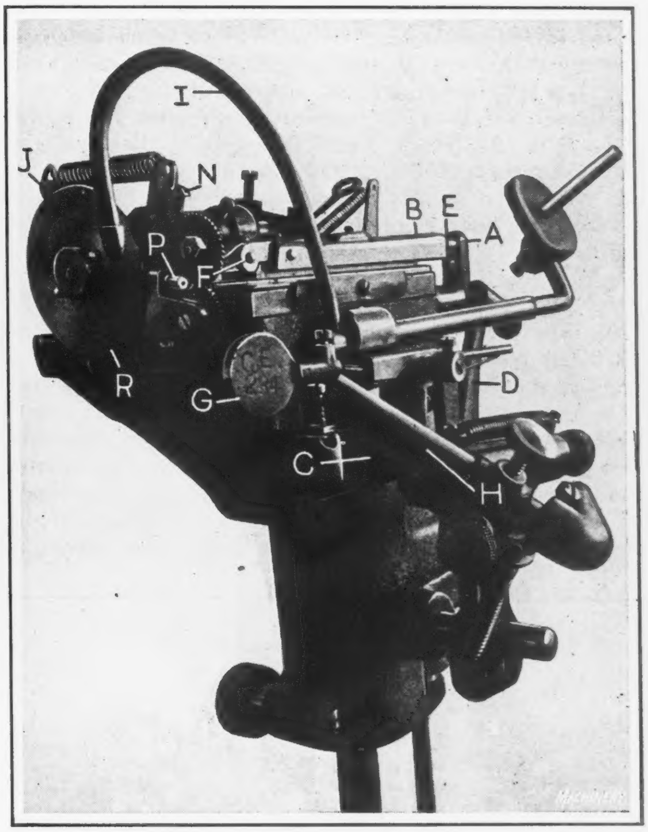


Fig. 3. Head with Cutters closed and Former in Position

arm *F* (Figs. 2 and 3) and causes the upper jaw to clamp against the wire. This jaw is pivoted to the hinge-arm, and drops down behind the lower jaw, so that as bell-crank lever *D* is advanced further, the entire slide is pushed ahead and the wire inserted into the glass button, which is now in a plastic state.

At the same time that the slide is fed forward in this manner, projection *A*, Fig. 4, on the side of the cam lifts the shield *G*, Figs. 2 and 3, so that the flame from nozzle *H* will be directed against the button on the glass stem. While the wire is being inserted, this shield drops. There is another connection for delivering a jet of air from pipe *I*, so that by the time the wire is inserted about 1/16 inch the glass will have hardened sufficiently to hold the wire. With the return movement of the slide, which is accomplished by spring tension, the upper hinged jaw is first released by rod *E*, so that it drags over the wire as the slide returns to its starting position.

The top side of the cam has three concentric lugs on it, as shown in Fig. 4, which actuate the movements of the cutters and pigtail-forming device. The wire is severed by two circular cutters; the upper cutter is carried on a lever having a projecting finger *J* (Figs. 2 and 3). This lever is fastened on a shaft that extends at *K*, Fig. 1. Finger *J* and a similar finger on the lever that operates the lower cutter are connected by means of a coil spring so that after the wire has been severed, the jaws will be drawn open.

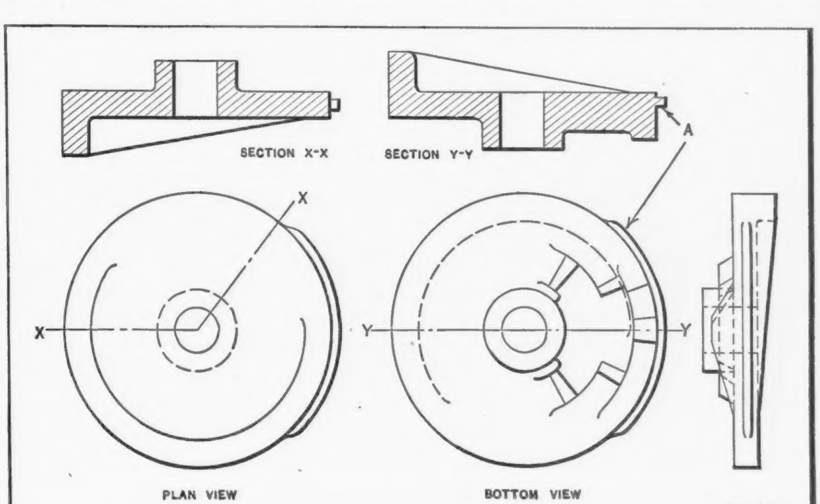


Fig. 4. Special Cam for actuating the Various Movements of the Machine Head

The end of shaft *K* has an arm with an adjusting screw bearing on a vertical slide *M* that is actuated by the outermost lug on the cam. This vertical slide has one supporting pin and one cam-pin under it, the latter extending through the main casting of the head to the cam lug. The shaft on which the lower cutter is carried is beneath the other shaft, and carries a finger *L* which extends back and bears on a vertical slide similar to that used to operate the other cutter. The innermost lug on the cam governs the movement of this lever.

Both of the cutters start to come together at the same time, but the lower one stops on the long dwell of the innermost cam lug, at the level of the wire, where it remains throughout the forming and cutting-off operations. Fig. 3 shows the closed position of the two cutters. In the course of the downward movement of the upper cutter lever, an adjusting screw *N* depresses a small spring lever at *O*, Fig. 2. The upward movement of the lower cutter lever has resulted in the wire being engaged by a step or hook on the end of former *P*. When the lever *O* has been completely depressed, it advances a small pin through this former, until it extends over the wire.

The next movement of the head is that which forms the pigtail, and it is accomplished by a partial revolution of the former through the medium of bevel gear *R*. On the rear end of the former there is a small bevel pinion which has remained in mesh with the bevel gear throughout, but

which has not been turned. The bevel gear is attached to a rod extending through the shaft or sleeve on which the lower cutter lever is attached. This rod extends at *S*, Fig. 1, is bent to form a crank, and projects through lever *T*. The intermediate lug on the cam now causes the vertical slide *U* to rise, which results in revolving the bevel gear and the former *P*, Fig. 2, thus curling the pigtail. Upon the completion of this movement the operative parts are returned to their respective starting points by means of springs.

Inserting Machine with Two Heads

As mentioned previously, the machine for inserting wires in the B type lamp stem is more complicated than that employing but one head. The design of the heads, however, is substantially the same, with certain exceptions as will be explained. As shown in Fig. 5, the same arrangement is employed for positioning the work-holder and for inserting the first wire, but in this machine another cam is necessary at the back for relocating the work-holder preparatory to inserting the series of anchor wires in the lower button.

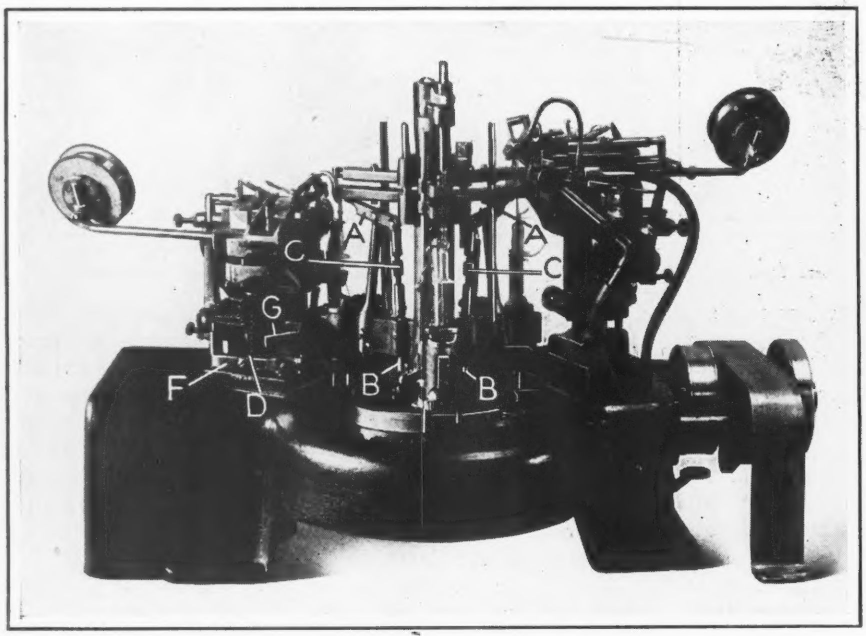


Fig. 5. Inserting Machine with Two Heads for inserting Wires in the Stems for Top and Bottom Anchors

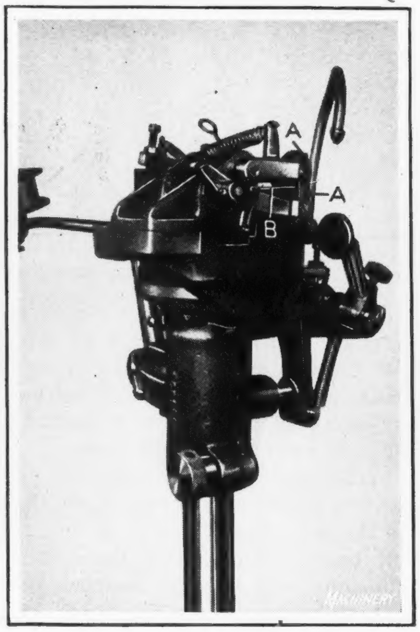


Fig. 6. Type of Head used on Machine shown in Fig. 5

The difference in the design of the heads is due to the fact that these wires are not formed with a pigtail curl, but with angular bends in a V-shape, those in the upper stem bending up, and those in the lower stem, bending down. Fig. 6 shows one of these heads used for bending the anchor wires up. The operation of the cutters and feed mechanism is the same as previously described, but in place of the former and the bevel gear arrangement for rotating it, there are two pieces of strip stock *A*, one on each cutter lever. The upper of these bends the wire down, and at the same time a stiff wire *B* on the lower cutter lever springs up on the inside of the upper strip and turns the end of the wire up, to complete the bend.

The fork levers *A*, Fig. 5, are operated by plungers *B*, from a cam at the rear. These plungers are connected by a link *C*. The purpose of this mechanism is to press the stems down at each station, to insure that they seat properly and in the correct horizontal plane, for the insertion of the wires. These levers are then lifted when the links drop by gravity, after passing over the cam.

The indexing of each work-holder is governed by a cam located on the shaft that carries the head, as shown at *D*, Fig. 5. The location of this index cam is the same in both types of machines. The cam actuates a lever *F* (see the heading illustration and Fig. 5) at the end of which there is a pawl. The throw of this pawl—that is, the number of ratchet teeth that it skips at every engagement—can be adjusted to suit the angular spacing of the wires being inserted. The movement of the pawl is back and forth with every revolution of the cam, and with every forward movement the pawl engages the ratchet wheel and turns the work-holder. The work-holder is prevented from turning while the wires are being inserted by a brake lever shown at *G*, which bears with sufficient pressure to prevent turning, except when the index-pawl is in engagement with the ratchet wheel.

* * *

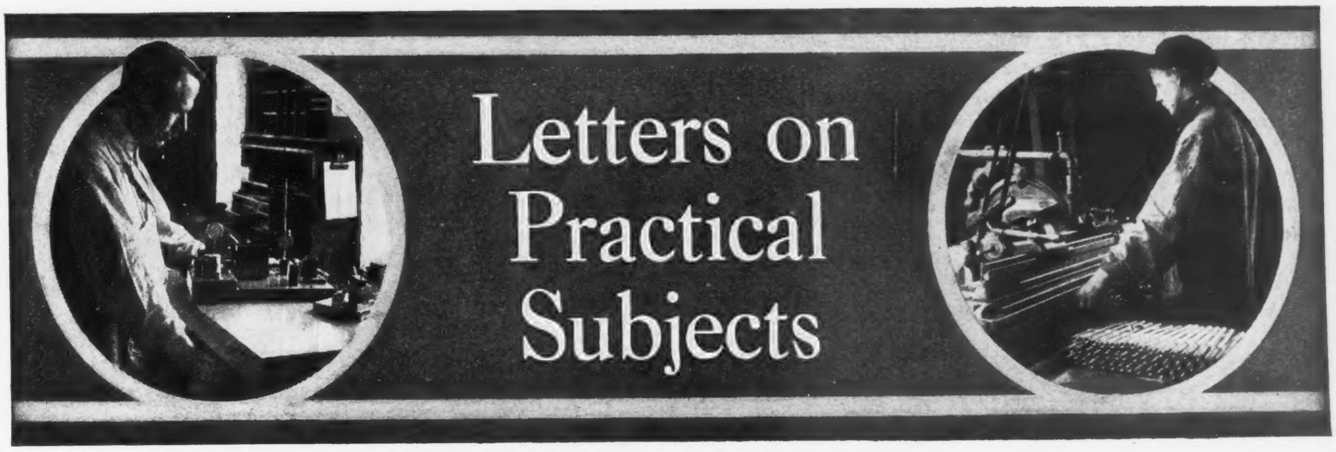
ONE-HUNDREDTH ANNIVERSARY OF AMERICAN RAILROADS

The American Railway Association has announced that plans are under way for a Railroad Centennial Celebration in connection with which a railroad exposition will be held. The American Railway Engineering Association, the American Railway Development Association, and the Mechanical Division of the American Railway Association have passed resolutions urging an appropriate celebration to mark one hundred years of American railroad development. Suggestions have been made to hold this anniversary celebration in Chicago, but no place has yet been definitely settled upon. The American centennial does not come until 1928, while the English celebration of the opening of the first railroad in the world will be held in 1925, when American railroads will participate. In that year, the hundredth anniversary of the opening of the first railroad will be held under the auspices of the International Railway Congress.

* * *

COMMERCIAL ORGANIZATIONS IN THE UNITED STATES

The Department of Commerce has just issued a revised and enlarged edition of "Commercial and Industrial Organizations in the United States." This edition contains a list of more than 11,000 organizations of local, state, national, and international character, conveniently indexed for ready reference. The current volume is the fifth edition of this directory. The growth and importance of commercial and industrial organizations in the United States is evidenced by the number of names listed in the present edition as compared with the 3200 associations included in the first edition, published in 1913. The directory may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., at a cost of 20 cents.



REMOVABLE JOURNALS FOR TEXTILE PLANT ROLLS

A great number of rolls made from brass and steel tubing are used in textile plants for carrying the cloth through various machines. These rolls are generally 44 inches long, $\frac{1}{8}$ inch thick, and 4 inches in diameter with a brass or cast-iron head *A*, Fig. 1, driven tightly into each end and provided with a $\frac{3}{4}$-inch gudgeon or journal *B*. The journals run in brass or cast-iron bearings which are held in brackets fastened to the sides of the machines. As the rolls are subjected to very severe use, the journals become worn in a short time and must be replaced by new ones.

Originally, the heads *A* were chucked in a lathe and a $\frac{5}{8}$-inch hole was drilled through the center and reamed to receive the journals. The journals were turned down on one end to fit the $\frac{5}{8}$-inch hole and were driven in tightly and riveted over, as indicated at *C*. The heads were next turned to a drive fit in the tubing *D*. After being driven into place, four 3/16-inch holes were drilled through the tubing and the head. A pin *E* was then driven into each of the holes. The assembled rolls were next placed between the lathe centers and the journals turned down to a diameter of $\frac{3}{4}$ inch, after which the rolls were ready for use.

When the journals wore out, considerable trouble was experienced in replacing them. To remove the first head from the tube, a small hole was drilled through one head, and the head at the opposite end was then driven out by passing a rod through the drilled hole. After the first head had been removed, it was an easy matter, of course, to remove the second head. The journals were then drilled out from the head and new ones were fitted in place and riveted over. Considerable time was required to replace the worn journals by this method, and much material was damaged in the process, as the thin tubing would not stand the strain caused by pushing the heads in and out.

In order to facilitate the replacement of the journals, the writer worked out the new design shown in Fig. 2, which resulted in a big saving in material and labor. A quantity of brass nuts *F* were drilled and tapped for a $\frac{7}{8}$-inch standard thread. The brass heads *A* were put in the turret lathe and drilled and tapped for the same thread as the nuts. The journals *G* were made from $\frac{7}{8}$-inch tobin bronze, and threaded on one end to fit the nut and the tapped thread in the head. The journals were centered and cut off from bar stock, after which they were centered on the opposite end. A 1/16-inch slot was cut in the nuts, as shown at *J*. The bevel or V-shaped bottom of the nut causes the top or slotted side to grip the thread on the journal stud when it is tightened against the end of the head *A*. The assembled head *A*, nut *F*, and journal *G* were then put in the lathe and the head turned to a tight fit for the tubing *D*. The heads were next painted with white lead and driven into the tubing, and four pin holes drilled as in the original design. Then the assembled roll was again put in the lathe and the journals turned to the required diameter.

When the journals became worn out, it was a simple matter to replace them by loosening the nut and unscrewing the journal. In most cases the nut would be so tightly clamped or frozen to the journal that both pieces would come out together. New journals could be easily put back in place and turned down so that the roll would be ready for ser-

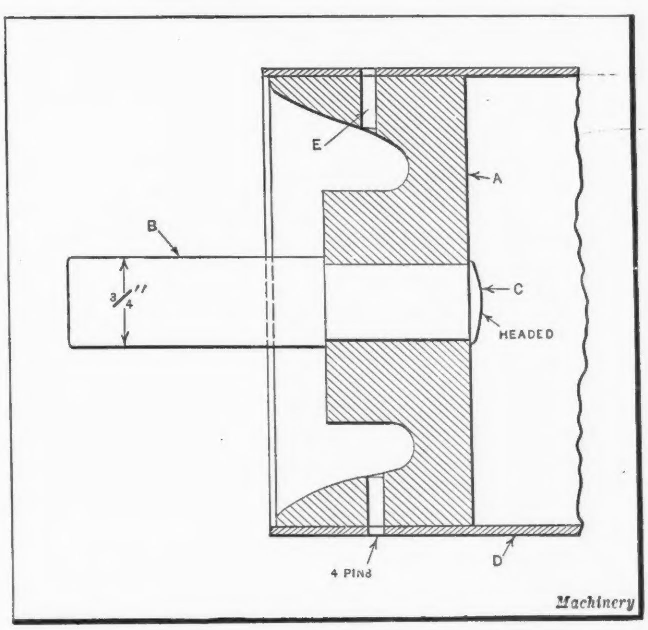


Fig. 1. Old-style Bearing replaced by New Design shown in Fig. 2

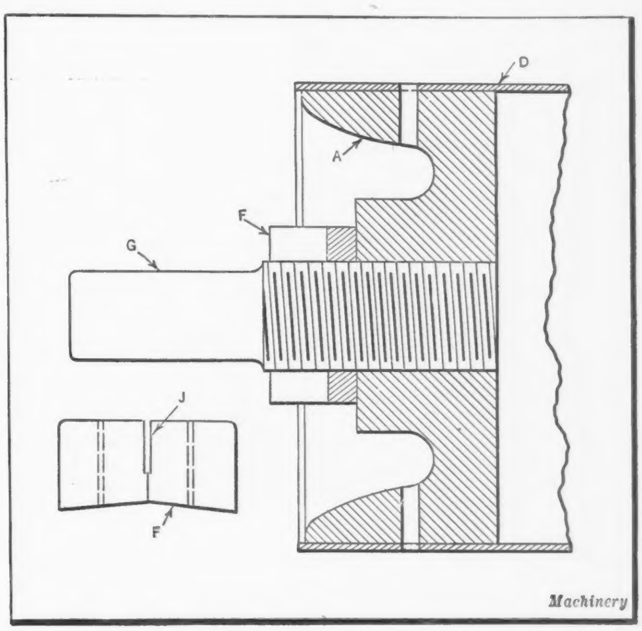


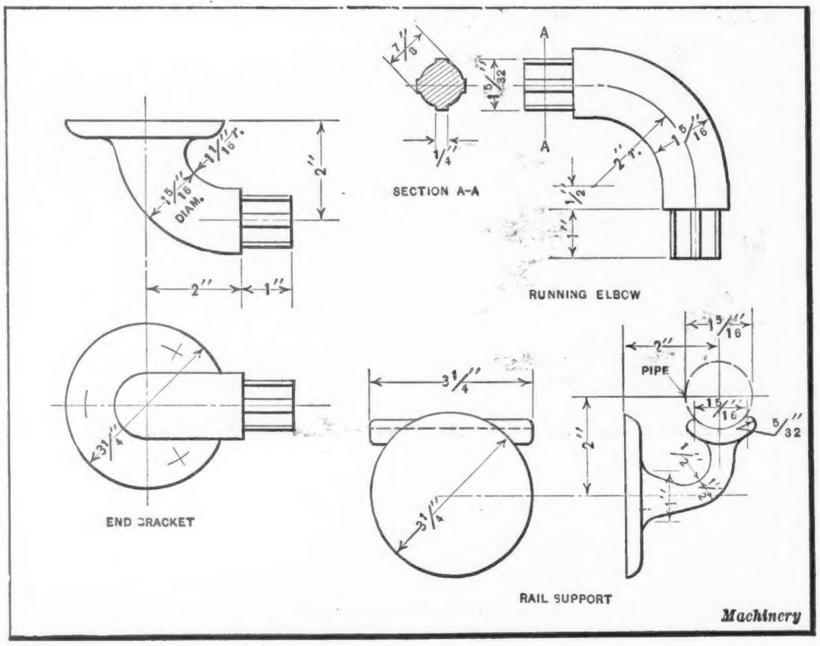
Fig. 2. Improved Design of Textile Plant Roll Bearing

vice and practically as good as new. Babbitted bearings were later employed in place of the brass boxes. The journals have been found to stand up longer with the babbitted bearings than with the brass boxes. It might be mentioned here that the journals and bearings operate in plain or soapy water or acid, depending on the operation or process being used. The effect of these solutions on the metal naturally has a tendency to shorten the life of the parts.

North Adams, Mass. CHARLES W. DALTON

DETAILS OF HAND-RAIL FITTINGS

The designer who has occasion to lay out a job on which rail fittings are used can find a full assortment of them in the catalogues of supply houses, and he can find the fittings themselves in stock in all the larger cities. These are standard malleable iron fittings, threaded the same as other pipe fittings, and are widely used in factories, power stations, etc., for guards, railings, table legs, and other framework constructed with iron pipe. But for hand railings in public service work, some type of fitting is desired—is often required—that is neater in appearance and that presents a smooth unbroken surface to the hand.



Flush Type of Hand-rail Fittings

Usually, special fittings must be made up for such work. As an aid to the draftsman, who prefers using something that has proved satisfactory elsewhere to the creating of a "standard" of his own, the dimensioned fittings here shown are offered. They are for one-inch pipe. Fittings for larger sizes may be made in proportion. While they could be cast in malleable iron, little would be gained by so doing. From the point of view of economy it would be advisable to have the fittings cast in gray iron. The ends of the fittings having the four cast-on strips or lands, as indicated in the sectional view, are a drive fit in the pipe. The pipe is ordinarily assembled on the fittings before securing the flanged bases to the wall.

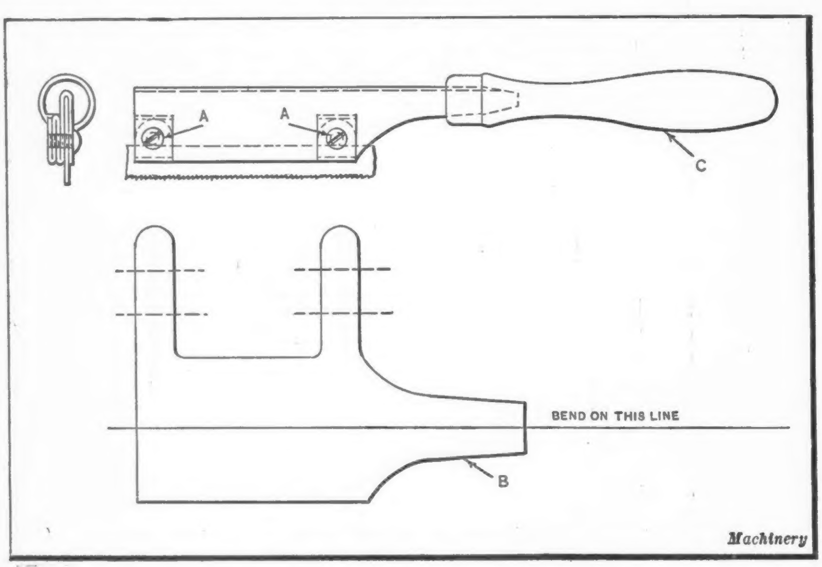
Middletown, N. Y. DONALD A. HAMPSON

HOLDER FOR BROKEN HACKSAW BLADES

Hacksaw blades are frequently broken before they are worn out, and even when worn to a point where they are usually discarded, it will be noted that only the center of the blade is really useless as a cutting tool. The simple holder shown in the illustration is easily made from 1/32-inch sheet steel or iron. The two parallel prongs shown in the development in the lower view are bent on the dotted lines and hammered until all faces are in contact, thus forming four thicknesses of metal for tapping, giving a threaded length of ⅛-inch for the two clamping screws *A*. After the prongs have been bent, the projection at *B* should be pointed so that it can be driven into the wooden handle *C*.

This tool will securely grip short sections of hacksaw blades, and will facilitate the cutting of slots in places where space is restricted and the permissible stroke is consequently shortened. A real saving in the cost of blades will be made as this tool can be used in many places where the regular frame is employed, in addition to its special uses.

Takoma Park, D. C. G. W. NUSBAUM



Hacksaw Blade Holder made from Sheet Metal

FINDING RESULTS TO FOUR PLACES ON THE SLIDE-RULE

A quick method of obtaining accurate results to four places in multiplying two numbers together on the slide-rule is described in the following. Proceed in the usual way, and read the result to three figures; then multiply mentally the last figure of the two factors in the problem, and place the last figure of the second result at the right-hand side of the three-figure result previously obtained.

For example, if 49 is multiplied by 59, the nearest reading to the eye on the slide-rule will be 289. The last figures of the two factors are 9 and 9; multiplying these gives 81. By placing the last figure (1) at the right-hand end of the three-figure result we get 2891. This answer can readily be checked by ordinary multiplication.

If the two numbers 23 and 53 are multiplied, the reading would appear to be about 1220, but as 3 times 3 equals 9 which is the fourth figure of the result, it is obvious that the last two figures should be 19, because that is a closer approximation to 20 than 29 is. Hence when the last digit is a large one, such as 8 or 9, the third figure of the result should be taken as one less than the third figure as it appears on the slide-rule.

Chicago, Ill. WILLIAM H. KELLOGG

SUB-PRESS DIE FOR WATCH PARTS

In making new dies for watch parts, it seems to be the general practice to employ the pillar type of sub-press design in preference to the older open-cylinder type. The writer believes that the pillar sub-press die is far superior to the open-cylinder type, as it is much simpler in design, costs less to produce, and is usually more accurate. The upkeep is also less, due principally to the fact that it has fewer parts. In Fig. 2 is shown a small blanked and pierced part which is used in the watches made by a large watch manufacturing concern. The "click," as this part is called, works in conjunction with the ratchet wheel attached to the main spring of the watch, its function being to prevent the spring from unwinding. Heretofore it has been the general belief that it was next to impossible to produce the teeth on these parts by the blanking method, the usual practice being to cut the teeth on a generating machine.

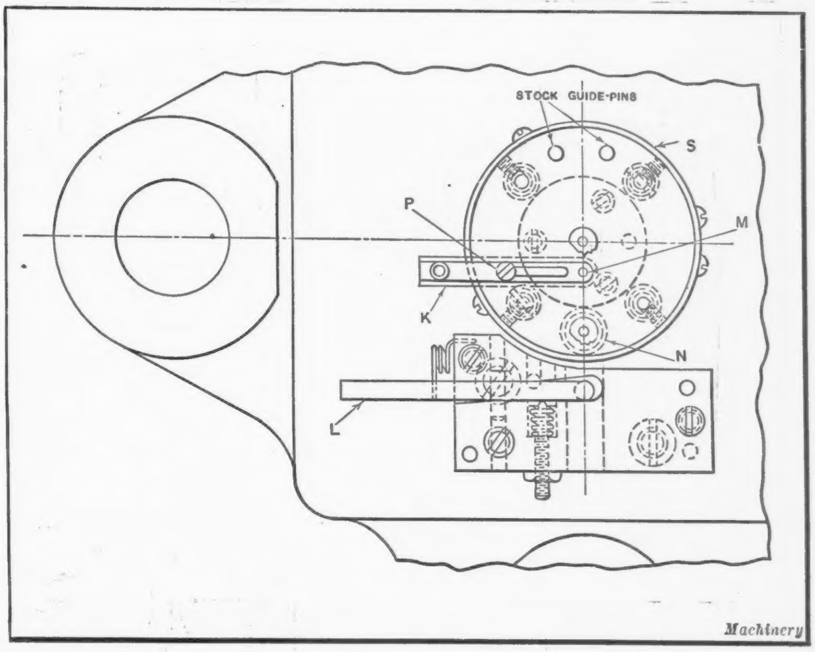


Fig. 1. Plan View of Punch and Automatic Stop used in making Part shown in Fig. 2

However, the pillar type of sub-press die which is shown in Fig. 5 has been successfully employed to produce these teeth. At one stroke of the press this die blanks the teeth, pierces the holes, and pushes the finished piece from the stock by means of a separate attachment termed a "knock-out." The method of holding the piercing punches is shown in Fig. 3. The material used for the watch part is Bessemer strip steel, 5/16 inch wide by 0.029 inch thick. It will be clear from Fig. 5 that on the downward stroke of the ram, die *A* compresses stripper *B* and punch *C* enters die *A*. The stripper or shedder *D* is then pushed up into die *A*, compressing the sub-press spring *E* in the ram plate. On the upward stroke of the press the blank, which has been pushed out of the stock into die *A*, is pushed back into the strip by shedder *D* through the medium of spring *E*.

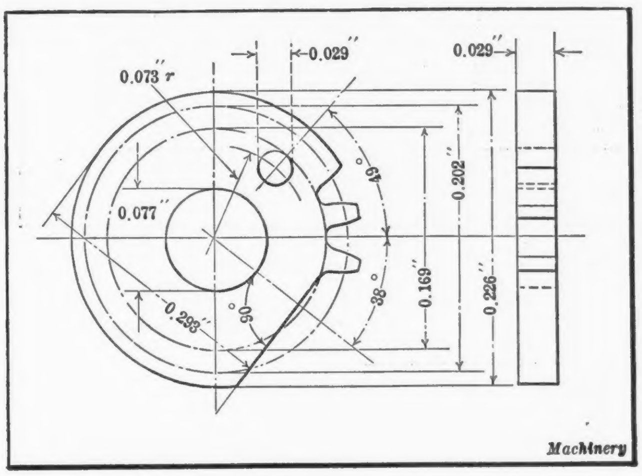


Fig. 2. Part for Watch produced by Die shown in Fig. 5

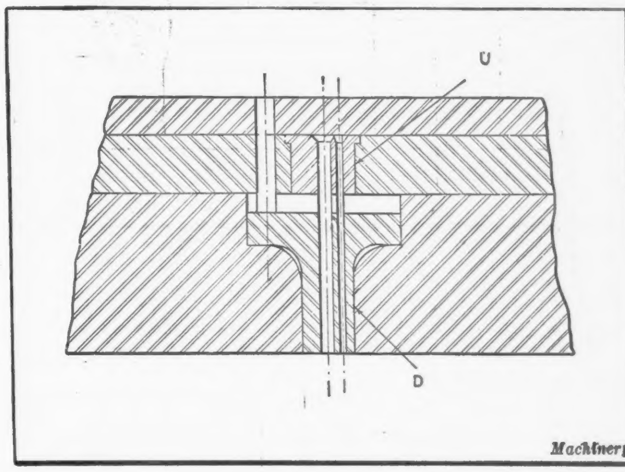


Fig. 3. Method of holding Piercing Punches in Die

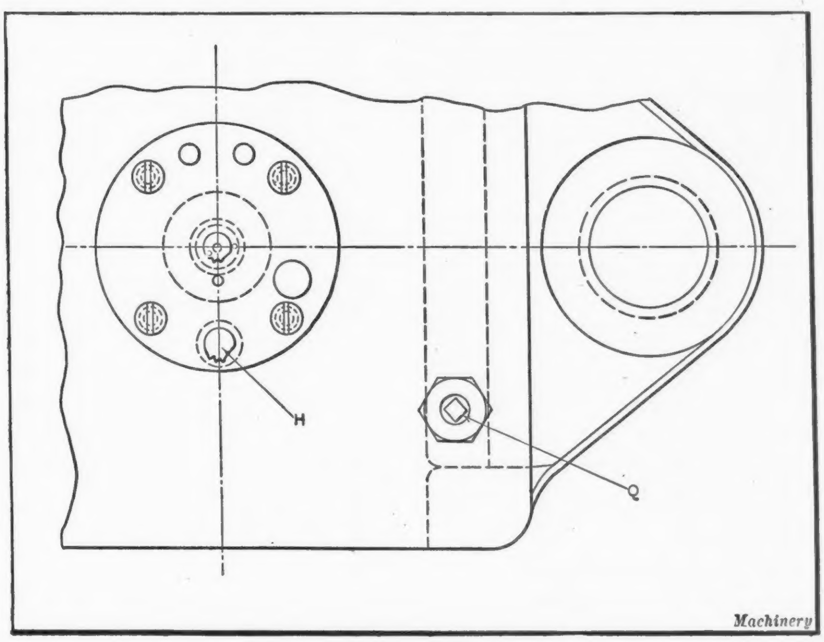


Fig. 4. Plan View of Die and Knock-out

Provisions for Locating and Ejecting the Work

In Fig. 1 is shown the plan view of the punch. Two stops are used in the design of this punch. The stock is first fed by hand up to the temporary stop *K* and then to the automatic stop *L*, after which the roll feed is used. On the second stroke of the press the strip is pulled over the pin *M* in stop *K*. On the fourth stroke of the press knock-out *H*, Fig. 4, comes into use. This knock-out pushes the blanked piece from the stock through tube *N*, Fig. 1, a receptacle being provided under the press to catch the finished pieces. At the sixth stroke of the press the temporary stop *K* is pulled back and clamped in position by screw *P*. The automatic stop *L*,

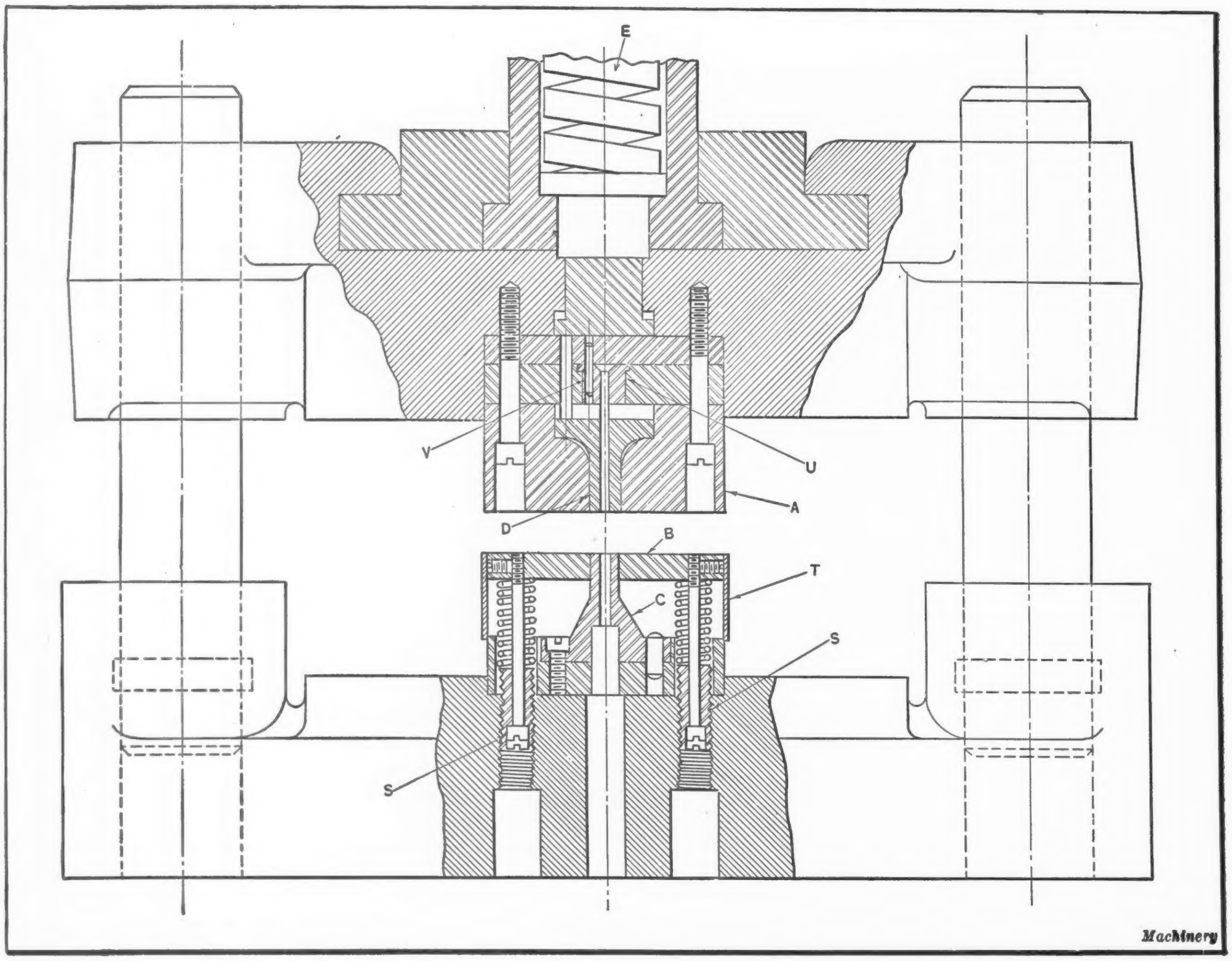


Fig. 5. Sub-press Die for producing Watch Click shown in Fig. 2

shown in Figs. 1 and 6, is of the trigger type, having a projecting end which is operated by the adjustable striking screw *Q* held in the die-block. The plate *R* of the automatic stop is ground down each time the punch is ground so that the stock will not be bent where it passes from the blanking die to plate *R*. The position of the knock-out *Q* is shown in Fig. 4.

The Adjustable Stripper

A novel feature of this die is the adjustable stripper *B*, Fig. 5. This stripper is so designed that it can be drawn down below the surface of the punch, to permit the latter to be ground, by simply turning the adjusting screws *S*, without in any way dismantling the die. A shield *T* is provided to prevent dust and dirt from getting into the springs and interfering with the action of the punch. The bushing *U*, Figs. 3 and 5, is held in place by a pin *V* shown in Fig. 5. It will be noted that the piercing punches are adequately supported at their cutting ends by the shedder *D*.

I. Bernard Black
Philadelphia, Pa.

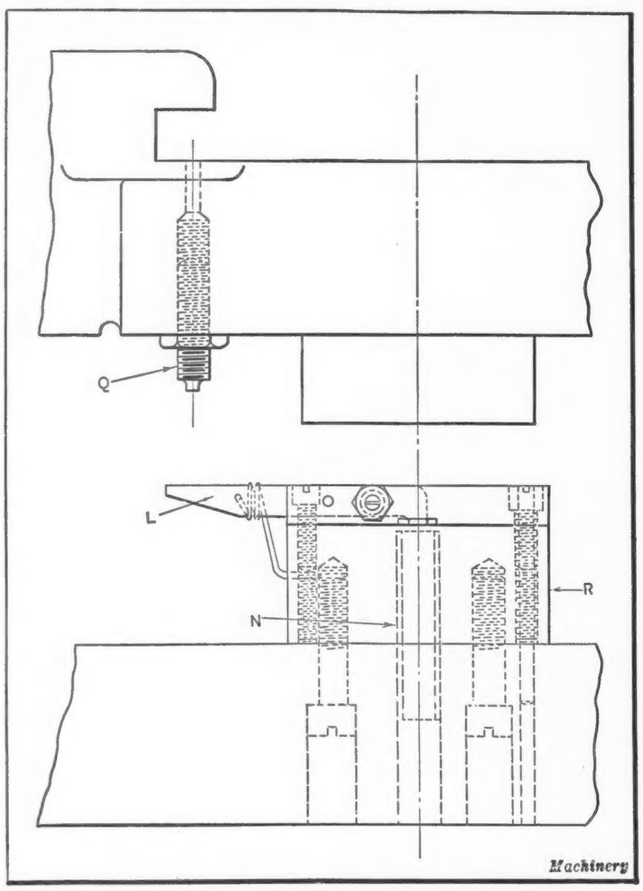


Fig. 6. Combination Knock-out and Stop

An estimate has been made by *Automotive Industries*, based on automobile registrations in the United States and the annual production of automobiles, according to which the average life of automobiles at the present time is about 6¾ years. Two years ago the average life appeared to be about 5 1/3 years. At the present time about 13,000,000 automobiles are registered in the United States. In 1922 nearly 2,600,000 cars were produced for domestic consumption. As registrations increased nearly 1,800,000 this indicates that about 800,000 old cars were "retired" during the year.

* * *

Increases in prices are a necessary accompaniment of business recovery. They are the vital stimulant to production. They do not mean inflation unless they continue to rise after full production is attained or unless they are the result of speculation. We have been steadily increasing our production for the last eighteen months; and we have had a very stable cost of living for over a year.

—*Herbert Hoover*

Questions and Answers

ROLLING THREADS ON THIN SHELLS

H. D.—There are a number of questions relating to the rolling of threads on bottle tops, lamp bases, and similar articles that I would like to ask:

1. How is the templet for making the tool with which to cut the rollers laid out?
2. How deep should the thread be cut in the roller? Are there standard dimensions for bottle top threads and for lamp socket threads?
3. How much smaller than the inside of the shell must the spindle roller be?
4. Is there any difference in the diameter of the rollers? On some thread rolling machines, I am told, the upper or outside roller is made as large as three times the lower or spindle roller.
5. Is there any formula for determining the outside diameter of the shell before it is rolled? For example, if a shell with a thread already rolled on it is available as a sample, how would one know what the outside diameter of the drawn shell should be, that will finish up to the same thread diameter?

ANSWERED BY FRED R. DANIELS, WATERBURY, CONN.

The following is submitted in answer to the foregoing questions, which were presented originally to MACHINERY'S readers in the September number. In order to answer these questions completely, it is essential that the design, or at least the principles of operation, of a commercial screw-cap threading machine be explained. An illustration of such a machine is shown in Fig. 1. This machine is of the universal type, that is, it is equipped with suitable tooling and provided with the necessary changes of speed for rolling threads on shells of various lengths and diameters. The machine consists of a train of gears at the driving end, by means of which the three important rotating members are driven at the proper speeds. The driving shaft at the rear carries a cam; the intermediate spindle carries a large swinging arm *A;* and the main spindle, at the front end, carries a work-arbor which supports the work at *B*. This arbor has a threaded end, and the shell to be threaded is placed over it. The thread is formed by the rolling action of the threaded roll or tool *C*, which swings down into contact with the work and rolls in unison with the work-arbor.

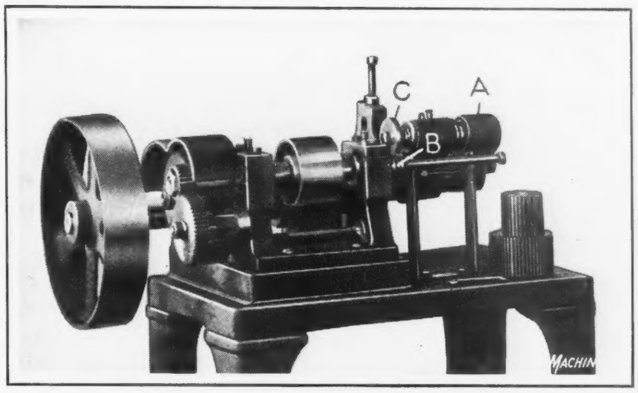


Fig. 1. Machine for rolling Threads on Tubes and Shells

The tool *C* is carried by arm *A* which derives its swinging movement from a cam. The dwell on this cam is such that from 1 to 1½ revolutions of tool *C* are made while in the full-depth position. The swinging arm carries a train of gears at the end for driving tool *C* at about the same peripheral speed as the work-arbor. Arm *A* has a sleeve-bearing on the revolving intermediate spindle, about which it oscillates at each revolution of the main spindle. The work-arbor held in the main spindle, and the threading tool in the swinging arm must revolve in opposite directions, and in such a way that when the threaded shell is grasped by the hand or by a mechanically operated stripper, it will unscrew from the arbor. The surface speeds must also be the same, or very nearly so.

Diameter Ratios of the Tools

In answering the questions raised, it is well first to consider the fourth one: "Is there any difference in the diameter of the rollers?", that is to say, the work-arbor tool and the swinging tool. There is always a slight difference and often a considerable difference. On large work, like fruit jar caps, or on medium sized work, such as electric light sockets and bases, all of which are short shells, the tools are of the same nominal diameter. This is the case because work of this size allows plenty of room for the operator to remove the shells without interference from the swinging arm, and also because a comparatively short time is required for the shell to unscrew from the arbor. The diameters of the tools are not exactly the same, however, owing to a condition that will be explained in a later paragraph.

On small-diameter work, however, such as pencil tips, or on shells over 1½ inches long, such as shaving soap boxes, it often becomes necessary to increase the nominal diameter of the tool in the swinging arm from two to six or even twelve times that of the stationary tool. The reason for this, in the case of small-diameter work, is that in order to get a small-diameter swinging tool out of the way in time to allow the work to be removed, the cam rise and fall would have to be too steep. Therefore the swinging tool is increased in diameter and decreased in rotative speed to maintain the equality of surface speed. The cam will then be decreased proportionately in speed, which permits the necessary time for swinging the arm back out of the way and forward again during one revolution of the driving shaft and intermediate spindle. In the case of long shells, the greater the time required to unscrew the shell, the more must the rotative speeds of the swinging tool and cam be decreased. The rotative speeds of the spindle tool and swinging tool are obtained by means of change-gears.

There is one point affecting the relative speeds of the tools that should be taken into account, and that is the fact that rolling the thread causes the shell to become sufficiently enlarged in diameter so that the surface speed of the arbor tool and of the work that it carries is slightly different. The resultant increase in surface speed of the rolled shell may mean that the threading tool must likewise be increased in surface speed. This is usually taken care of by making the swinging tool from 1/64 to 1/32 inch larger in diameter than the nominal diameter of the arbor tool when the ratio is 1 to 1, and multiples of this increment for larger swinging tools, that is 1/32 to 1/16 inch larger for a ratio of 2 to 1, 1/16 to ⅛ inch larger for a ratio of 4 to 1, and so on. The exact amount that this enlargement of the work will affect the surface speed of the swinging tool is difficult to determine except by experiment.

Design of Tools—Templets

In answering the first question, "How is the templet for making the tool with which to cut the rollers laid out?", there are various factors to be considered. The tools are of equal face width, and they revolve several times while forming a deep thread, and from 1 to 1½ times after the full depth has been reached; consequently they must be ac-

curate in lead, as otherwise double impressions will be formed. This likelihood is aggravated by the fact that the shell increases in diameter during rolling, which increases its surface speed.

The tendency is for a closed-bottom shell, like a lamp base or a bottle cap, to increase more in diameter at the open end and become bell-mouthed, as shown at the left in Fig. 2. This can be overcome by the design of the tools. The shape of the thread is similar to the Whitworth standard, but with larger curves at the root and the crest. The shape enables the thread to be rolled gradually with the least amount of stretch in the metal, thus minimizing the tendency to bell-mouth. The portion of the thread where stretch is most likely to occur is on the flanks at *A*; consequently a slight modification in the form of the tools is often necessary, as indicated by the dotted outline. With this exception, the threads in the tools are the same shape as those to be rolled.

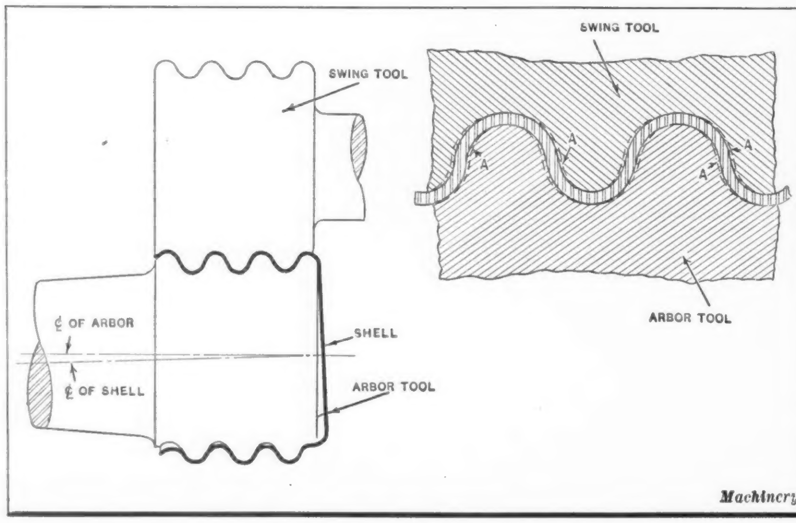


Fig. 2. Diagram at Left shows Tendency of Shell to become "Bell-mouthed," and Diagram at Right shows Modifications in Thread Form for the Tools

If templets are made with which to gage the turning tools for the thread-rolling tools, they will need to be laid out by cut-and-try methods, because the amount of relief necessary to prevent stretching the metal at *A* is dependent on various factors, such as the physical properties of the metal, the pitch and number of threads, and other conditions of an undeterminable nature. The writer knows of no dependable rule that could be employed to take the place of experimental methods.

Standards for Screw Cap Threads

As to the second question relative to depth and standards for rolled threads, the writer does not know of standards for such shells as bottle caps, fruit jar caps, or tubes, although the same general shape used for electric lamp sockets and bases is employed. On this latter class of work there are accepted standards among the manufacturers of electrical equipment, complete information for which can be obtained from Report No. 1474 of the Transactions of the A. S. M. E., volume 37, page 25, edition of 1915.

Diameter of Arbor Tool—Diameter of Drawn Shell

In answer to the third question, the outside diameter of the arbor tool should be slightly smaller than the inside diameter of the drawn shell, say 0.020 to 1/16 inch for medium-sized shells, or enough so that the shell will slip over the tool easily.

While there are no formulas, as far as the writer knows, for determining the outside diameter of a drawn shell that will produce a threaded shell of given outside diameter, some information may be gathered from the accompanying table which contains data obtained from actual work performed on the type of machine illustrated in Fig. 1. It will be noticed from this table that where the ratio of the tools is greater than 1 to 1, the swinging tool has multiple threads in the same ratio. For instance, if the diameter of the swinging tool is about twice that of the arbor, a double thread is used, so that the helix angle of the thread on the swinging tool is at least approximately the same as the helix angle on the arbor; consequently, as the arbor and swinging tool revolve together the threads mesh properly. The table referred to also contains tool diameters for different ratios. It will be noted that the diameter of the swing tool is slightly larger than that of the arbor tool, even for a ratio of 1 to 1.

The machine illustrated in Fig. 1 is the product of the Waterbury Farrel Foundry & Machine Co., Waterbury, Conn., and is typical of a line of machines that this company manufactures for performing threading, beading, knurling, and similar operations on drawn shells. This particular view shows a machine set up for threading long tubes. The threading operation is, of course, performed on that end of the tube adjacent to the nose of the spindle, and there is a long extension arbor which merely serves to support the tube from the inside. In threading such parts as caps, shells, etc., the arbor simply has a threaded end, as illustrated in the left-hand diagram, Fig. 2.

* * *

THE AUTOMOBILE INDUSTRY

The outstanding feature of the industrial situation in the metal-working field is the automobile industry. The usual seasonal decline in automobile production has not materialized. The September output of passenger cars and trucks was nearly 330,000, a decline of only 5 per cent from the August figures, and an excess of over 60 per cent over the corresponding month last year. The decline is extremely small for the season, because a falling off of from 20 to 25 per cent is usually expected. For the remainder of the year there will, of course, be reductions in output, some plants having already announced that they will curtail production; but the General Motors Corporation has given out very optimistic reports, a production of 91,000 cars having been scheduled for October, which is said to be the highest in the history of the company. Several makers have announced lower prices for the 1924 models.

TOOLS FOR SCREW-CAP THREAD ROLLING

Name of Part	Outside Diam., Inches		Threaded Length, Inch	Metal Thickness, Inch	Ratio of Tools	Swinging Tool		Diam. of Arbor Tool, Inches
	Before	After				No. Threads	Diam., Inches	
Electric lamp sockets..	1.010	1.025	1/2	0.010	1 to 1	1	61/64	15/16
Fruit jar caps.........	2.489	2.593	3/4	0.017	1 to 1	1	2 15/32	2 7/16
Radiator valves	1.094	1.135	1/4	0.014	2 to 1	2	2 1/8	1 1/32
Shaving soap boxes....	1.059	1.100	1/4	0.020	4 to 1	4	4 5/32	63/64
Lantern filler screws..	0.395	0.406	3/16	0.018	4 to 1	4	1.580	0.359
Long tubes	0.514	0.562	3/8	0.025	6 to 1	6	3.072	0.453

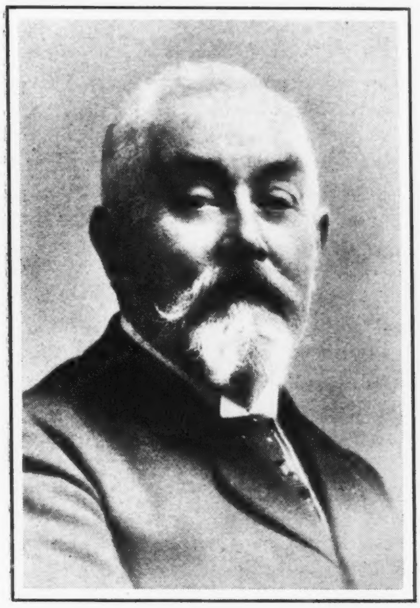
Machinery

A PIONEER FRENCH MACHINERY HOUSE

By HENRY D. SHARPE

Mr. Francis Fenwick, the head of Fenwick Freres & Co., well-known Paris agents for a large number of American machine tool concerns, died at his home in Croissy-sur-Seine near Paris on Friday, September 21, in the seventy-third year of his age. He was born in Paris on April 18, 1851, the eldest son of an English father and a French mother. The history of his life is largely the history of the business to which he devoted all his life.

The business was founded by his father and mother in 1862, and from the first, and for a great many years, was devoted solely to commission undertakings for American and other foreign buyers. In 1885 Mr. Francis Fenwick became associated with his parents and brother, and later, in 1888, on the death of his father, became the head of the firm now called Fenwick Freres & Co., Commission and Export, with their location at 21 Rue Martel. During all these years, he made frequent trips to America where he was favorably known to numerous merchants in our leading cities who were accustomed to buy articles of European manufacture.



Francis Fenwick

The entrance of the firm into the business of representing American manufacturers of machine tools grew out of a close friendship with the late Lucian Sharpe, one of the founders of the Brown & Sharpe Mfg. Co. In 1888, on bidding farewell to Mr. Sharpe in Providence, he casually inquired if Mr. Sharpe had anything which he could sell in France. To this Mr. Sharpe replied that he might be able to dispose of some hair clippers, and provided him with samples. Soon after his arrival home, cable orders commenced to come in, and during successive years continued in large amounts.

The following year—1889—occurred the Paris Exposition, at which the company had an exhibit of considerable importance, over which presided Mr. F. G. Kreutzberger, lately retired as director of the well-known Arsenal of Peuteaux, a man of splendid mechanical ability and experience. Following the exposition, it was only natural that Mr. Kreutzberger's mechanical abilities should be seconded by the Fenwick interests, which had begun to represent the Providence concern; so between them they took the agency for selling machine tools in France and neighboring countries. Mr. Kreutzberger, however, soon retired, as his age was not equal to the responsibilities, and Fenwick Freres & Co. became the sole representative. Becoming incorporated as the Societe Anonyme des Etablissement Fenwick Freres & Co., the house took the agency for various American concerns, and through ensuing years assumed the representation of many others. The expansion of this business later necessitated removal to more commodious quarters, which were built at 8 Rue de Rocroy, where they are now located.

In the upbuilding of the business during these years, whether of commission or of export, Mr. Francis Fenwick was the dominating force. Knowing little of the technical side of engineering, he yet possessed a business skill of no mean order, a real ability in administration, and a wonderful gift for friendship which was a most valuable asset.

In 1908 he was decorated by the government as Chevalier of the Legion d'Honneur. Later he was made president of the Chambre Syndicale des Importateurs Francais, fostered by the government, according to its custom, which was to prove so useful in the war. He was vice-president of the Comptoir d'Achats des Machines-Outils and a member of the Comite Interministeriel des Machines-Outils and d'Outillage Mechanique at the War Department. These various positions were only a small indication of the esteem in which he was held in France.

Mr. Fenwick possessed a great power of work, attending to his business until the very last days of his life, never relaxing his interest in important things and the welfare of all his employes, everyone of whom had his confidence and came to know his rare charm.

His family life was impressive to everyone who knew it, his able and devoted wife, Madame Charlotte Fenwick, having been his constant companion and help in his long business life. As a boy he went through the horrors of the siege of 1870, and when the World War came on, he was known to say that he never believed he would again have to witness such agony for his country; but through the long struggle he was ever stoical and confident of success, never bending even when his able and beloved son, Captaine René Fenwick, so popular among his men and officers, was killed in Flanders on April 28, 1918. He then made a point to try to obtain his consolation in contemplating all the beauty of the sacrifice endured, in a greater devotion to his work, and in the love of his four grandchildren to whom he was ardently devoted.

The American machine tool industry has lost a devoted friend in the death of Mr. Francis Fenwick.

* * *

MEETING OF SOCIETY FOR STEEL TREATING

The annual meeting of the American Society for Steel Treating, held in Pittsburg, October 8 to 12, was characterized by a large attendance. An extensive exhibit of steel, steel products, steel-treating apparatus, and machine tools was held in connection with the convention. This year a new arrangement was made for the holding of the technical sessions and the exhibition; the former were held in the morning at the William Penn Hotel, six miles from the exposition, which was housed in the Motor Square Garden, and the latter did not open until the afternoon, so that the two events did not conflict with each other.

The technical program contained a long list of papers relating to almost every branch of the use and treatment of steel in industrial work. Among the subjects dealt with were the manufacture of automobile springs, oxy-acetylene welding, heating furnaces and fuels, heat-treatment of steel, manufacture of sheet steel, automobile steel specifications, casehardening, manufacture of heavy forgings, spark testing of steel, effect of heat-treatment on lathe tools, crystallization of iron, X-ray examination of steel castings, magnetic indication of hardness and brittleness, hardness testing of steel and brass, and the aging of steel. Complete copies of these papers are published by the American Society for Steel Treating, 4600 Prospect Ave., Cleveland, Ohio.

* * *

MATERIAL FOR SNAP GAGES

The standard type of snap gage is generally a drop forging made from a steel containing 0.20 per cent of carbon. The size of the gage is milled to within 0.005 to 0.010 inch of the correct size, after which the gage is carburized, reheated, and hardened on the measuring points only, by quenching in oil. It is then ground to size and lapped to a smooth surface. Built-up snap gages for special manufacturing work are made from 0.20 per cent cold-rolled steel, and are carburized, reheated, and hardened in the same manner as standard snap gages. They are milled before hardening to within about 0.005 to 0.010 inch of the correct size, and are ground and lapped after hardening.

The Machine-building Industries

WHILE shipments of several of the older and well-established machine tool builders are at present stated to be only about 60 per cent of the 1913 average, it must be remembered that many new firms have come into existence since that time, and several shops that were either very small or did very little business in 1913, now have far greater capacity and a corresponding output; thus, for example, one of the medium-sized plants in the Middle West states that its shipments are now from 300 to 400 per cent of the pre-war output, which was very small. It is exceedingly difficult to obtain exact figures covering the machine tool industry as a whole, but if the industry could be taken as a unit, the actual shipments and output today are doubtless considerably in excess of 60 per cent of the 1913 business. Unfortunately, no statistics covering the entire industry will be available until next year, when the Census Bureau will issue its compilations gathered from all the machine tool building plants in the country.

Whatever the actual figures may be, it remains a fact that most of the machine tool shops are working far below capacity, and there is no evidence of greatly increased business for some months to come. Ernest F. DuBrul, general manager of the National Machine Tool Builders' Association, advises a conservative, carefully planned business procedure for some time to come, with definite plans based upon a careful study of general business conditions. It will be a period during which alertness to trade opportunities and selling ability will count greatly. The business will not be evenly distributed, because it is likely to go chiefly to those most active in trying to get it. Generally speaking, it is unwise to stock up machines at this time, because business is not likely to come back with such a rush that machine tool builders cannot meet the demand by a gradual return to normal production.

Activity in Different Lines of Machine Tools

Although actual sales during September and October were below expectations, inquiries in many lines indicate a latent demand, and while it is more difficult to make predictions at this time than it has been for several years, many manufacturers believe that November will produce more sales than any month since last spring. Shops building machinery especially suitable for locomotive and railway repair shops have had a business averaging higher than the majority of other plants. There has been some falling off in this field also, because the buying earlier in the year provided many of the locomotive and railroad shops with the necessary equipment. At present there is a revival in the buying of locomotives and other railroad equipment, and this may again stimulate further machine tool buying.

In the special machinery field, there has been considerable activity throughout the year, and several shops in this line are occupied nearly to capacity. In the automobile shops, many standard machine tools that need replacement are not being replaced by the same kind of machines, but by special single-purpose machines for high production. This, of course, applies only to plants producing in quantity on an interchangeable basis. A number of machine tool builders are busy improving designs, and in certain lines, as for example in the grinding machine field, several new machines have recently been placed on the market, and other developments will doubtless follow. Rapid-production tapping machines are in active demand, and at least one of the shops in this field is working to capacity.

Export business, which is comparatively small compared with three years ago, has improved, but the change is slight. A number of machine tools have been bought for export to Russia, and it is expected there will be further buying from this source. Many inquiries have also been received from Japan.

The general activity in the machine-building industry is marked, and there is no indication of any serious falling off in the nation's business. This is evidenced by the demand for equipment outside of the machine tool field. Cranes, hoists, and chain blocks have sold well throughout the year, and while new orders are not coming in at present as rapidly as in the spring, several of the plants in this field have enough business on hand to keep their shops going for the rest of the year.

The Small Tool Industry

Taken as a whole, the small tool industry may be considered normal; the demand is particularly good in special small tools, die-heads, and tapping equipment. Several of the shops in this field have all the work they can handle, and one, at least, is planning to expand its manufacturing facilities. Plant expansion should, however, be considered with great care, because, as a whole, the industry has an over-capacity. The most important development in this field would be to so standardize the product that a greater output is possible with present facilities.

In the small tool field, the railroads, automobile shops, and garages have been the principal buyers. Many of the small shops that formerly made special tools, jigs, and fixtures have turned their attention to the making of garage accessories, and some have been quite successful in this new line. Generally speaking, the equipment of most garages and automobile repair shops is below par, and there is a great opportunity for the development of efficient but inexpensive garage and repair shop equipment.

The Iron and Steel Industry

Production in the iron and steel industry is less at present than at any previous time during the year. The U. S. Steel Corporation is working at about two-thirds capacity, while the September average for most of the independent steel companies was about 70 per cent. New orders are not coming in as rapidly as earlier in the year, but part of the decrease in new business is said to be due to the fact that the mills are now making such prompt deliveries and the railroads are handling the freight with such expedition that steel consumers find it unnecessary to buy far ahead for future needs and are using their stocks for present requirements. A considerable steel business is expected for reconstruction work in Japan. The production of pig iron in September was 6 per cent less than for August.

General Business Conditions

The Federal Reserve Bank states that production in the basic industries was 2 per cent less in August than in July, August being the last month for which complete statistics are available; but it is also pointed out that the August production was 27 per cent greater than a year ago, and is higher than it has ever been in August, except in 1918.

It is estimated by the Federal Reserve Bank that production in pig iron, steel, copper, coal, cement, and automobiles was higher than normal, indicating active conditions in practically all of the larger industries. This would hardly indicate that we are entering upon a period of marked depression in business; but as normal conditions are more likely to result when the business world is conservative, and there is careful planning along progressive lines, new enterprises should be undertaken only after adequate deliberation, and new financing should be carefully considered.

New Machinery and Tools

The Complete Monthly Record of New Metal-working Machinery

American Gear-Tooth Grinder

IT is a generally accepted principle of manufacturing that the most economical method of accurately finishing hardened parts is first to rough out the work, then heat-treat, and finally finish to size by grinding. When this sequence of operations is followed, precision of dimensions is assured, because grinding after hardening not only brings the work down to size, but it also eliminates the inevitable distortion that occurs in heat-treating.

This principle of manufacturing is now being employed with noteworthy success in the making of hardened gears. The method of procedure is to machine the blanks, rough-cut the teeth, and then heat-treat the work. After hardening, the hole or stem is ground to serve as a locating point in setting up the work for finish-grinding the profiles of the teeth to insure accurate spacing and perfect form. Gears manufactured in this way cost little more—as far as machine work is concerned—and they may be depended upon to give satisfaction in so far as quietness of running and other properties related to accuracy of the tooth form spacing and concentricity with the bearing are concerned.

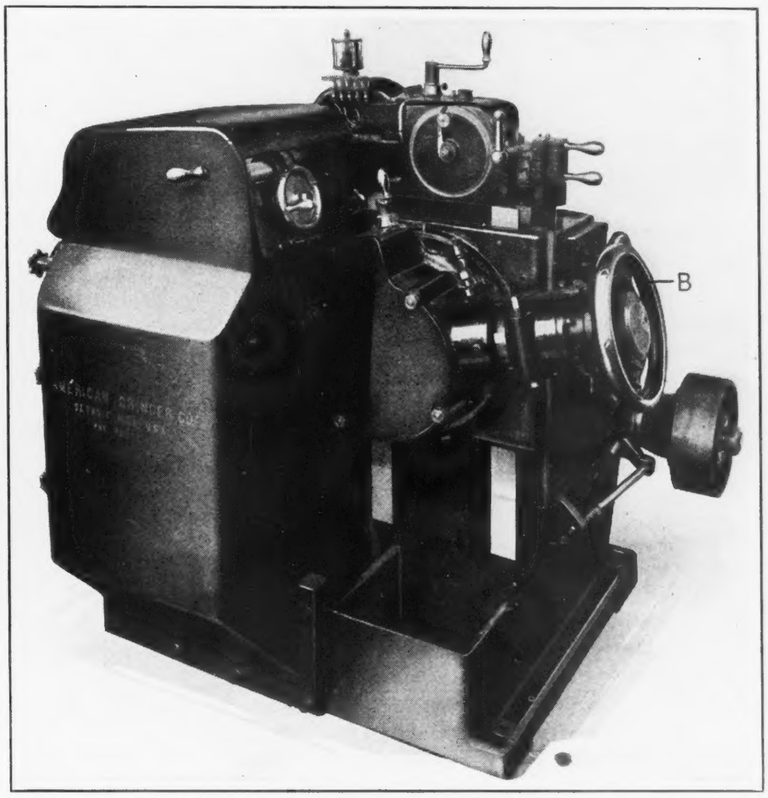


Fig. 1. Generating Type of Gear-tooth Grinder made by the American Grinder Co.

For use in grinding gears in accordance with the preceding method, the American Grinder Co., 6534 Benson St., Detroit, Mich., has recently perfected a machine shown in Fig. 1, which represents a further improvement in design over previous equipments built by this company for handling the same class of work. This machine operates on the generating principle, as illustrated diagrammatically in Fig. 2. It is adapted for grinding spur gears from 1½ to 8 inches pitch diameter, with teeth from 12 to 3 diametral pitch, and with face widths up to 2 inches.

General Arrangement of the Machine

The gear to be ground is rolled in contact with an imaginary rack, and grinding is accomplished by a wheel 30 inches in diameter, the face of which corresponds with one side of a tooth of the imaginary rack with which the gear rolls during the generating action (see Fig. 2). The grinding spindle is carried on a slide which remains fixed while the machine is working; but this wheel-slide has a swivel adjustment

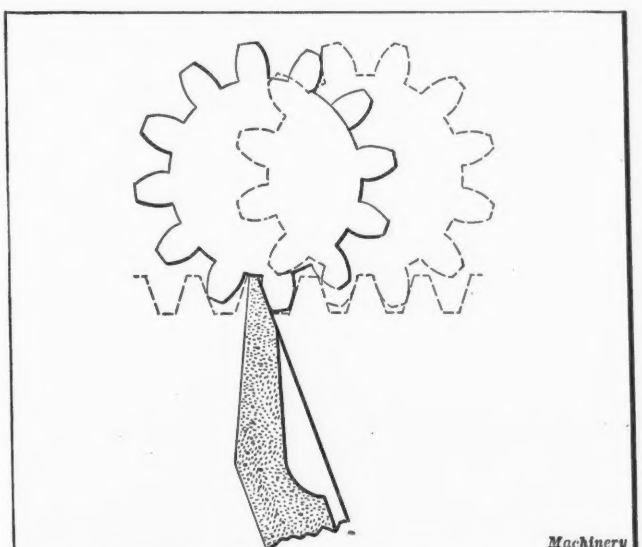


Fig. 2. Diagram illustrating how Flat Side of Grinding Wheel generates Tooth Curves as Gear rolls along an Imaginary Rack

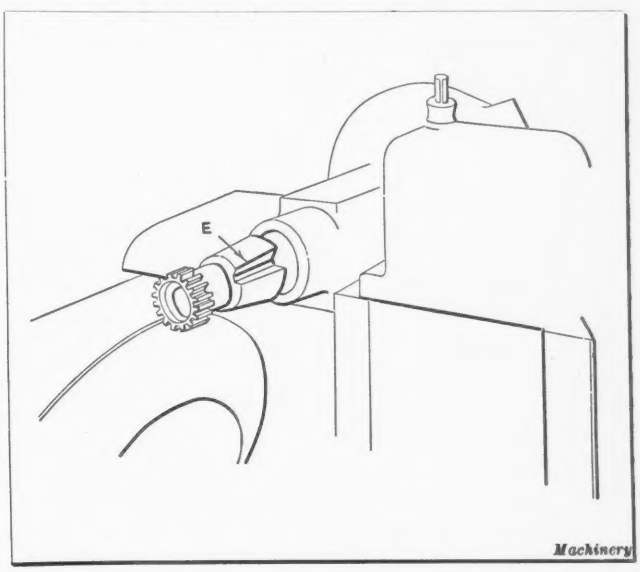


Fig. 3. Sketch showing the Notched Collar which is employed for readily locating the Gears to be ground

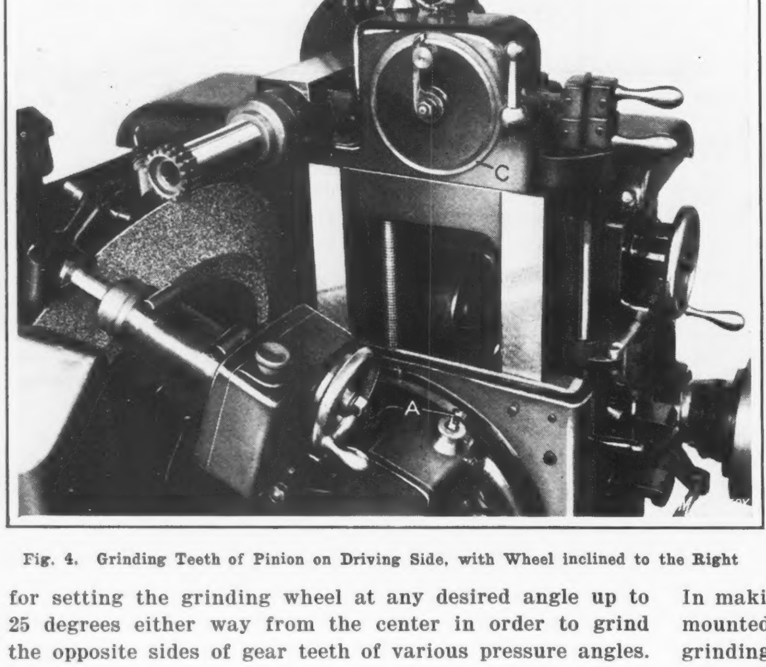


Fig. 4. Grinding Teeth of Pinion on Driving Side, with Wheel inclined to the Right

for setting the grinding wheel at any desired angle up to 25 degrees either way from the center in order to grind the opposite sides of gear teeth of various pressure angles. Figs. 4 and 5 show opposite settings of the wheel. These adjustments are made by crank *A*. There is a hand-operated adjustment for setting the grinding wheel which will be explained later. This is effected by means of graduated handwheel *B*, Fig. 1.

The Rolling-gene ating Action

Either gears with the usual center hole or stem-gears may be ground. The former are held on an arbor, and the latter have the stem gripped in a collet chuck. A transverse slide carries the work-spindle, and there is a roller mounted on the under side of this slide that runs in the groove of a barrel cam. Secured to the back of the work-spindle, there is a cylinder of the pitch diameter of the gears to be ground. Two steel tapes are wrapped around this cylinder in opposite directions, each tape having one end secured to the cylinder and the other to the frame of the machine. As the cam reciprocates the slide, these tapes rotate the work-spindle and cause the gear being ground to roll in contact with the rack-tooth face of the grinding wheel, thus producing the generating action. A screw adjustment provides for keeping the tapes taut around the cylinder. The tapes are only required to roll the work; otherwise, they are free from all load.

Indexing the Work

Secured to the rear end of the work-spindle, there is also an accurately finished, notched index-plate having the same number of spaces as the gear to be ground. This index-plate locks the tooth that is being ground, in relation to the grinding wheel, as the work-slide advances and returns. Such an advance and return of the work completes the grinding of one side of one tooth. As the work leaves the grinding wheel, an automatic mechanism releases the index-plate and turns the gear through one space, after which the index-plate is again automatically locked, ready for grinding the next tooth. Three pairs of change-gears are furnished for grinding one side of a tooth on an ordinary automotive transmission gear in four, five, and six seconds, respectively. The cam that reciprocates the work carriage or slide provides a smooth motion free from all shock.

The Automatic Stop—Setting up the Machine

It is considered good practice to take two cuts over each side of each tooth on the gear that is being ground. Referring to Figs. 4 and 5, it will be seen that there is a dial on case *C*. Inside this case there is a notched disk on which a trip may be set to disengage the drive to the grinding wheel and to the cam that reciprocates the work-slide. If the work is to receive two revolutions in contact with the grinding wheel, so that two cuts will be taken over each face of the gear teeth, the pointer on the dial is set to twice the number of teeth on the work. If only one cut is to be taken, it is set to the same number as the number of teeth on the work. Each time the carriage reciprocates, a stop turns the notched disk in case *C* through one space; and when one or two complete revolutions of the work have taken place, whichever the case may be, the trip in case *C* operates and throws out the driver to the work-slide as well as to the grinding wheel.

On its return stroke, the work-slide stops in such a position that the work is away from the grinding wheel, making it convenient to remove the ground gear and substitute an unground one. In making a preliminary set-up of the machine, the gear is mounted in place and then brought into contact with the grinding wheel at about the pitch line of the gear. The hand adjustment of the grinding wheel, by means of graduated handwheel *B*, Fig. 1, is then employed to secure the desired depth of cut. The preceding description applies only to the preliminary set-up of the machine. After the operation has once been established, changing of work is a simple matter of routine. Referring to Fig. 3, it will be seen that a notched collar *E* is placed on the work-arbor. To set up a gear for grinding, it is put loosely on the arbor, after which a wedge-shaped blade is dropped into the notch in collar *E* and into one of the spaces in the gear. Then the work is clamped on the arbor and is properly located for grinding.

From the preceding description it will be apparent that the operation of this gear-tooth grinder is fully automatic after the work has been set up and the machine started. The work-spindle is at a convenient height from the floor, to facilitate loading blanks and unloading ground gears. The grinding wheel is under the work and carried in substantial bearings, free from vibration. Automatic control enables one operator to look after two or more machines.

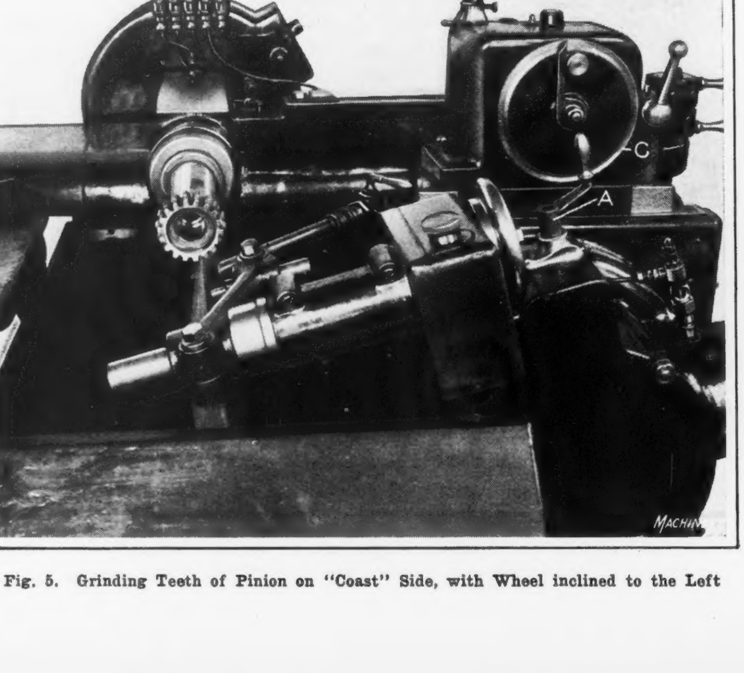


Fig. 5. Grinding Teeth of Pinion on "Coast" Side, with Wheel inclined to the Left

BROWN & SHARPE SPUR AND SPIRAL GEAR HOBBING MACHINE

A new gear-hobbing machine known as the No. 44 spur and spiral gear hobbing machine has recently been brought out by the Brown & Sharpe Mfg. Co., Providence, R. I. In designing and constructing this machine, the fact has been recognized that a hobbing machine, more than almost any other machine tool, must have high accuracy "built into it" if its product is to be accurate to a high standard. Care has been taken in building this machine not only to meet this requirement, but also to amply proportion and design the parts so that the machine will remain accurate during years of steady service.

All bearings are amply large, all shafts are well supported, spiral bevel gears are used wherever practicable, and every precaution has been taken to prevent the development of backlash in the operating parts. The machine is conservatively rated and is strong enough in all its parts to do the work day after day and retain its accuracy. It will hob either spur or spiral gears up to 18 inches in diameter and 3 diametral pitch in cast iron or 4 diametral pitch in steel. The low and compact design of the hob-slide and swivel locates the hob-spindle close to the ways and insures great rigidity. The heavy overhanging arm and rugged arm brace provide a firm support for the work. Additional support for heavy gears is supplied by an adjustable rim-rest. All handwheels and controlling levers are conveniently located on the front of the machine within easy reach of the operator. The controls are simple, and many labor-saving innovations have been included in the design. This machine is equipped with a differential that permits the use of any feed desired, regardless of the gearing for the index or lead. By employing this differential, only one set of lead gears is used for any number of teeth for a certain pitch and angle. The differential is entirely automatic in operation, becoming locked when a gear is removed, as in cutting spur gears.

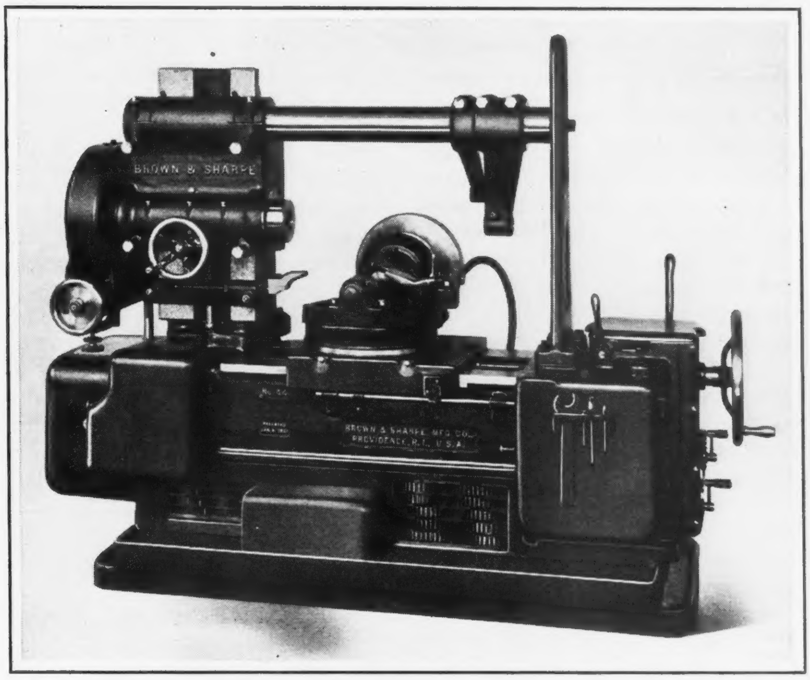


Fig. 1. Brown & Sharpe No. 44 Spur and Spiral Gear Hobbing Machine

The drive comes to the machine through the friction pulley (see Fig. 2) and passes to the speed change-gears, then forward to the hob-spindle and index mechanism and returns along the rear of the bed to the hob-slide feed mechanism. The friction pulley can be driven direct from the main shaft, thus eliminating the use of even a simple countershaft. The machine, being self-contained, is readily adapted to motor drive, and when so equipped the motor is mounted on a bracket at the rear where it is out of the way, yet readily accessible. The friction type of pulley permits the hob-slide to be traversed by power when the hob is stationary. The outer end of the main drive shaft is carried in ball bearings held in a rigid supporting arm. The drive leaves the friction pulley sleeve and enters the feed-box, from which power is derived for the hob lubricant pump and the hob-slide rapid advance and return mechanism, independent of the driving of the hob.

The main drive shaft, which is driven through a friction clutch within the pulley, transmits the drive through to the front of the machine where, by means of change-gears, the power is transmitted to the splined hob-spindle driving shaft. The change-gears give ten changes of speed in geometrical progression from 45 to 166 revolutions per minute, for the hob-spindle. A bevel gear on the splined shaft meshes with another on the center of the swivel, and this takes the drive through a short horizontal shaft and helical spur gears to the hob-spindle. The hob-spindle is hardened and ground and runs in long bearings. The front bearing is removable, permitting easy adjustment and quick changing of hobs up to 5 inches in diameter. Accurate end adjustment is obtained by means of a screw having graduations which indicate the movement by 0.005 inch. This machine can use either a 1¼- or 1½-inch hob-spindle (the 1¼-inch being standard) and has 1½ inches adjustment endwise to provide for using several sections of the hob before resharpening.

Another feature is the application of a balance wheel on the hob-spindle itself which tends to steady the cutting action of both the hob and the machine and eliminate chatter. In addition, the hob-spindle driving gear runs in a heavy bearing so that the driving gear pressures are carried by this rather than by the hob-spindle; thus the hob-spindle bearings carry the cutting or hob load only. The balance wheel is securely locked to the hob-spindle, and as the spindle is a close fit in the gear, the weight of the wheel is carried by the driving gear bearing. The energy of the balance wheel is thus transmitted to the hob-spindle as useful turning effort, without its weight having a tendency to cause an excessive amount of wear in the hob-spindle bearings. The hob-slide is a substantial casting with large flat bearing surfaces and long ways. All gears in the hob-slide and swivel are securely held so there will be a minimum of backlash. The hob-swivel is graduated and may be swung to 90 degrees either side of zero. By means of a vernier, settings to five minutes are readily obtained. This distinctive feature—swiveling either side of zero—permits the full range of the machine (both in angle of helix or length of face) to be utilized in cutting either right- or left-hand spiral gears.

The splined hob-spindle drive shaft *A*, Fig. 3, after passing through the hob-slide extends to the left end of the machine, where it connects with the differential inside the bed. The shaft *B*, with the spider of the differential on it, rotates, thus driving the opposite shaft *C* at twice the speed. From shaft *C* motion is transmitted through change-gears to the index-wheel. Up to this time, the differential has not come into play and the machine acts like a spur gear machine. When the feed starts, however, the horizontal shaft *D* under the rear hob-slide way, which is connected with the feed-screw in the feed-case, begins to revolve and transmits power through bevel gears to the lead change-gears at the front of the machine. The lead change-gears are easily calculated for any particular job by means of a simple formula, and for a given pitch and angle of spiral, the gears remain unchanged regardless of

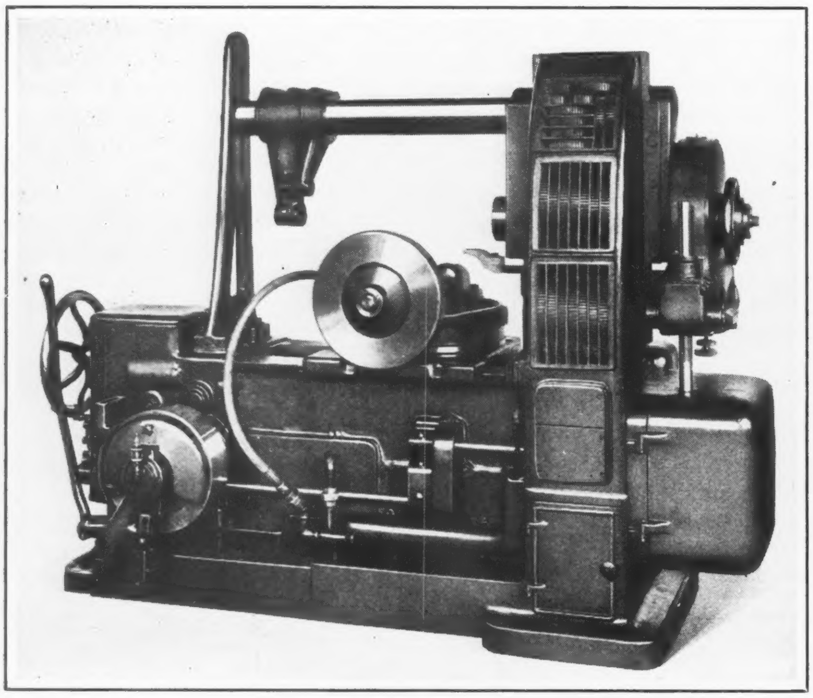


Fig. 2. Rear View of Brown & Sharpe Spur and Spiral Gear Hobbing Machine

the number of teeth or hand of spiral. After passing through the lead change-gears, the drive runs back to the differential where, by means of a worm, it drives the worm-wheel *E* keyed to the right-hand gear of the differential. As soon as this gear begins to turn in either direction, the driven shaft *C* of the differential is accelerated or slowed down, as the case may be, and the resultant change of relative speed between the hob-slide and the index-wheel produces helical teeth.

The driven shaft of the differential carries the drive through to the index change-gears *F*, which provide for cutting all numbers of teeth from 6 to 50 and all numbers from 50 to 180 except prime numbers and their multiples. After leaving the change-gears, the drive passes to the vertical shaft *G*, and then through spiral bevel gears to the index worm shaft. The double-threaded index worm which engages the worm-wheel runs in oil and is hardened and ground all over. The index worm is clutched to its sleeve, which runs in bronze bearings lubricated by a ring-oiler. This sleeve has mounted on it a ball thrust bearing so that end play can always be eliminated. On the end of the sleeve facing the operator is a handwheel through which, after two nuts are loosened, the worm can be operated by hand. This is of great value in recutting gears, as the handwheel has graduations to indicate the relative adjustment of the work-arbor. The worm can also be dropped out of mesh so that the index-wheel can be turned by hand when truing up the work-arbor. The index-wheel is of gray iron, finish-hobbed in place.

The front end of the work-spindle has a No. 16 taper hole in it with a 2½-inch hole through the center for holding shafts. It is fitted to receive a faceplate or fixture. The work-spindle slide is adjusted by means of a screw operated by a handwheel, and the thrust of the elevating screw is taken by ball bearings. A dial graduated to thousandths of an inch indicates the adjustment. The outer end of the work-arbor is supported by means of a large overhanging arm equipped with arm braces. This arbor support has an adjustable center if needed, or a bushing can be used. A device is furnished for relocating the arbor support when the support has once been centered. Additional support for large gears is furnished by an adjustable rest placed back of the rim of the gear opposite the hob.

When the drive leaves the index change-gears, part of the power is used to drive the hob-slide, the power first passing through a horizontal shaft at the rear of the machine. By means of transposing gears and a set of three bevel gears (which take care of the direction of rotation for right- and left-hand hobs) power from the horizontal shaft is transmitted to the feed change-gears in the feed-case on the right-hand end of the machine. Twelve changes of feed in geometrical progression are provided, ranging from 0.010 to 0.153 inch per revolution of the work. After leaving the change-gears, power is delivered to the hob-slide feed-screw through a worm and a clutched wheel. The feed-screw is actually a lead-screw, as it is very accurately made and can be easily removed for replacement, if necessary.

Two spiral bevel gears, having an intermediate gear and a clutch between them to give reversal, are mounted on the friction pulley drive shaft and drive the first hob-spindle change-gear at the front of the machine. On the hub of the bevel gear nearest the driving pulley, is mounted a larger bevel gear that runs free on the driving pulley sleeve and that rotates whenever the driving pulley turns, whether or not the friction is engaged. This large bevel gear drives its mate, which is mounted on a shaft from which the feed-case lubricating pump and the mechanism for effecting quick movement of the hob-slide are driven. A vertical lever on the front of the feed-case engages a friction clutch in either one of two gears which are driven in opposite

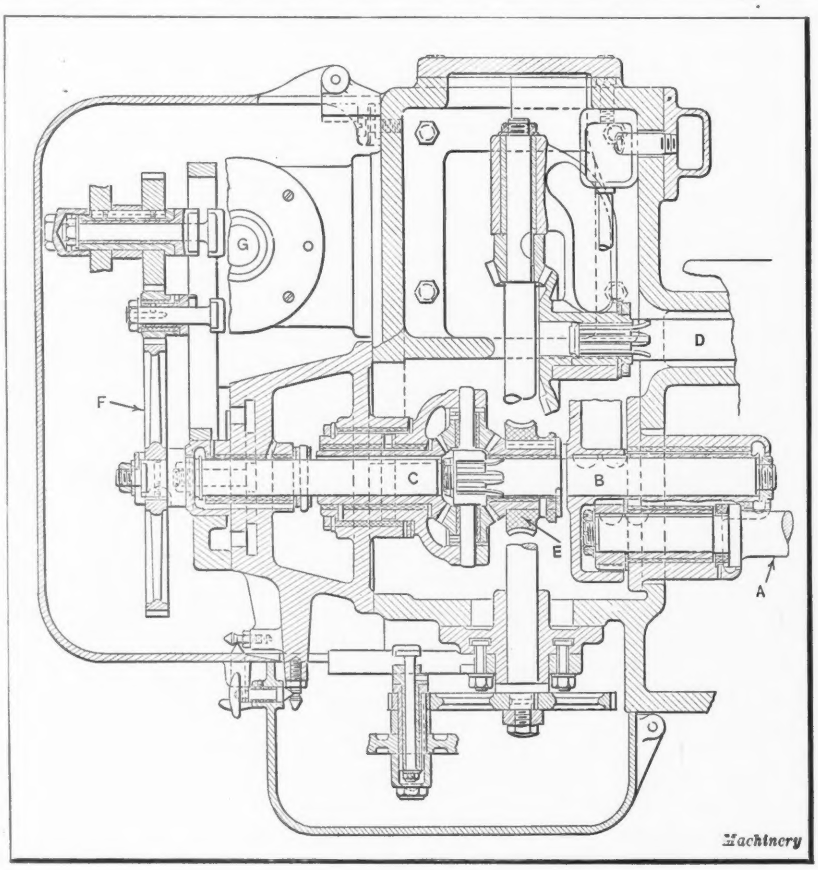


Fig. 3. Differential Mechanism and Adjacent Parts

directions. This lever throws in the quick traverse mechanism. The hob-slide also may be moved forward or back as may be required, by means of a handwheel on the right of the feed-case. A complete set of charts is furnished with each machine so that the operator may see at a glance the proper position of the levers and gears for any particular job.

The feed-case and differential mechanism are automatically lubricated by means of a pump in the feed-case. The hob lubricant solution is pumped through piping and a flexible tube to a flat nozzle, assuring an even and well distributed supply, without splash, over the entire cutting surface of the hob. Oil guards, which are mounted on the spindle, prevent the cutting solution from running into the hob-spindle bearings. The chips and the cutting lubricant, in dropping through the hob-slide, do not come in contact with any moving part to clog up bearings, gears, etc. The chips are retained in the base, and the solution is returned to the main reservoir for circulation.

The base is of exceedingly heavy construction, with rigid internal bracing, and has compartments for storing all change-gears furnished with the machine. The floor space required at right angles to the hob-spindle, with the covers open, is 104 inches, and parallel to the hob-spindle, with the covers open, 57 inches. The net weight is about 6840 pounds. This large amount of metal assures rigidity and freedom from vibration, which are important factors in hobbing accurate gears.

M-G PRODUCTION UNIT

For the performance of drilling, tapping, boring, facing, milling and similar operations on a large variety of parts, at high production rates, the Meldrum-Gabrielson Corporation, Syracuse, N. Y., has brought out the No. 2 M-G "Production Unit" shown in Fig. 1. This unit consists of two complete machines mounted on one base, the construction permitting two operations to be performed successively on

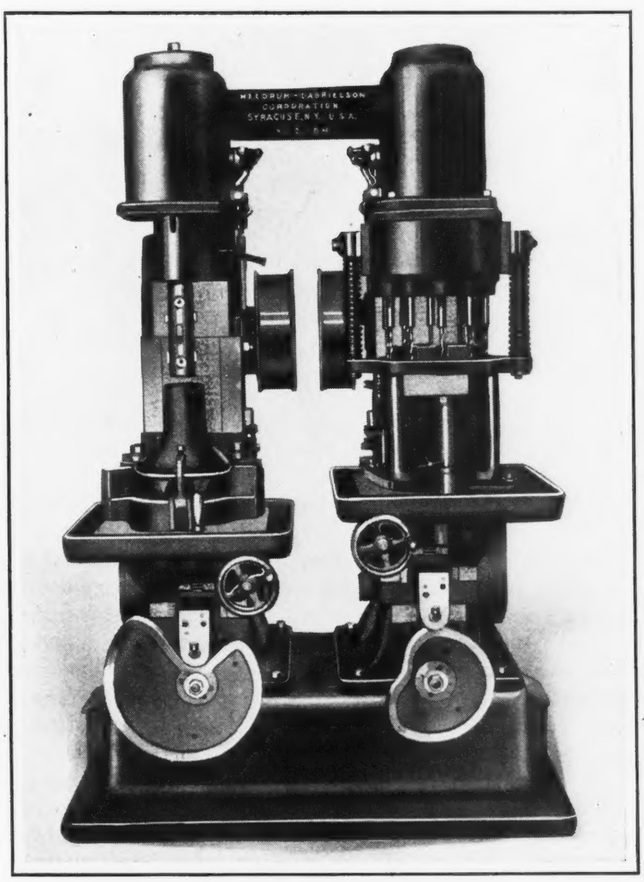


Fig. 1. M-G Production Unit for drilling, boring, facing, milling, etc.

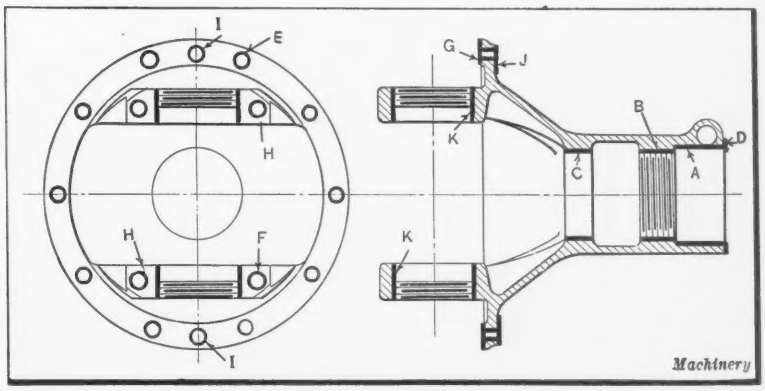


Fig. 2. Automobile Differential-gear Carrier

the same part. The timing of the table movements is such that when one of the tables is stopped for reloading, the other is feeding the work during the performance of the machining operation. The spindles have no vertical movement, and the tables in the standard design are fed toward the spindle by means of cams. However, there may be special set-ups in which the table may be stationary or have a lateral movement relative to the column, as will be described later. The operation of both sides of the machines is automatic except for reloading and starting. They are designed to drive a two-inch drill through solid nickel steel.

Special heads, driven direct from the machine spindle, are used for most work. A spindle nose having a standard taper socket is regularly supplied; this nose is made separate from the spindle so as to facilitate the use of special boring-bars and heads. The nose and boring-bars seat on a circular extension of the spindle and are attached to a flange on the spindle. Multiple drill heads are attached to the column. The spindle rotates in three ball bearings, two of which are of the double-row type. The work is held in jigs fastened to the table, and the desired movement is imparted to the tables by means of the cams clearly seen in Fig. 1, the contours of which are made to suit each job. Each cam raises and lowers its respective table through the medium of a roller held in a bracket attached to the table saddle. The tables themselves may be adjusted vertically on the saddles by a rack and a pinion which is revolved by a handwheel at the front of each table.

A constant-speed pulley running at 450 revolutions per minute and equipped with a friction clutch of the expanding type drives each machine. In this respect, and in several minor ones, the unit has been improved over the construction illustrated, in which a countershaft is used for driving the pulleys. The distance between the column centers is 33 inches.

Mounted direct on the pulley shaft within the column is a sliding gear by means of which two different spindle speeds are instantly available. This sliding gear is operated by a handle on the column. The drive to the spindle is through a shaft above the sliding gear shaft, on the rear end of which is mounted a change-gear that meshes with another directly above it. By interchanging these two gears, two more spindle speeds are quickly available, and by substituting others, practically any speed may be obtained. There is also a stud and idler gear which may be mounted between the speed change-gears for the purpose of running the spindle in the opposite direction. On the upper change-gear shaft is also mounted a bevel pinion which drives a gear on the lower end of an angular shaft that extends up through the head of the column and has a bevel pinion at the upper end that drives the spindle through a gear mounted directly on it.

The sliding gear on the pulley shaft also meshes with either of two gears beneath it for delivering power to the shaft on which the cam is mounted. One of these gears meshes with a gear provided with both spur and bevel teeth. The bevel teeth mesh with a bevel pinion mounted on the top of a vertical shaft, the lower end of which carries a

worm. This shaft is mounted in a bracket that is automatically swiveled when the cam completes its cycle, disengaging the worm from its mating gear and thus stopping the movement of the table for reloading. It can also be operated manually during any part of the cam cycle. The table is stopped once at each revolution of the cam. In disengaging the drive in the manner just explained, the bevel gears are not unmeshed, one simply rotating a short distance around the teeth of the other.

From this worm-gear shaft the drive is through a pair of change-gears to a second worm-shaft directly beneath. The worm on this shaft drives a large bronze worm-wheel on the camshaft. The speed of the camshaft is not changed in shifting the sliding gear on the pulley shaft, but by transposing the two change-gears just mentioned, two camshaft speeds are quickly available. Any speed may, of course, be obtained by substituting the necessary change-gears.

Attached to the column beneath the large worm-gear and extending into the base is a casting which serves as an oil reservoir. Oil is pumped from here to the top of the column, whence it runs over all gears and shafts contained in the speed and feed transmissions. Practically all these gears are mounted on splined shafts, and the gears and shafts are made from chrome-nickel steel and heat-treated. All shafts, with the exception of those on which the feed change-gears are mounted, are carried in ball bearings. A pump is also provided for delivering coolant from the base of the machine to the cutters. The distance from the center of the spindles to the face of the columns is 12 inches, and the weight of the complete unit is approximately 6500 pounds.

The versatility of this equipment may be illustrated by an example of work done on it. By the use of an installation consisting of five units, the automobile differential-gear carrier shown in Fig. 2 is completely machined in less than fifteen minutes. The set-up of one unit for the first and second operations is shown in Fig. 1, the left side of the machine being equipped with a boring-bar for rough-boring surfaces *A*, *B*, and *C*, and facing end *D*, Fig. 2. Then the part is placed in the right-hand fixture and the ten holes *E* and two dowel-holes *I* are drilled around the flange, and four holes *F* are drilled in bosses that extend to the center line of the cross-bore. In the left-hand position an air chuck (not illustrated) is used to hold the work in place, while in the right-hand fixture the jig-bushing plate holds the work under spring pressure.

End-milling cuts around the entire surface *G* of the flange and over the top of each boss *H* are taken by means of the second unit. This operation is illustrated in Fig. 3, the machines being equipped with special heads, each of which carries four end-mills, two for rough-milling and two for finish-milling the surfaces mentioned. Both sides of this unit are set up alike. In this case the table has no vertical movement, the cams being used to move the fixture sideways to bring the surfaces to be machined under the cutters. The fixture is then rotated by means of worm-gearing driven from the pump shaft.

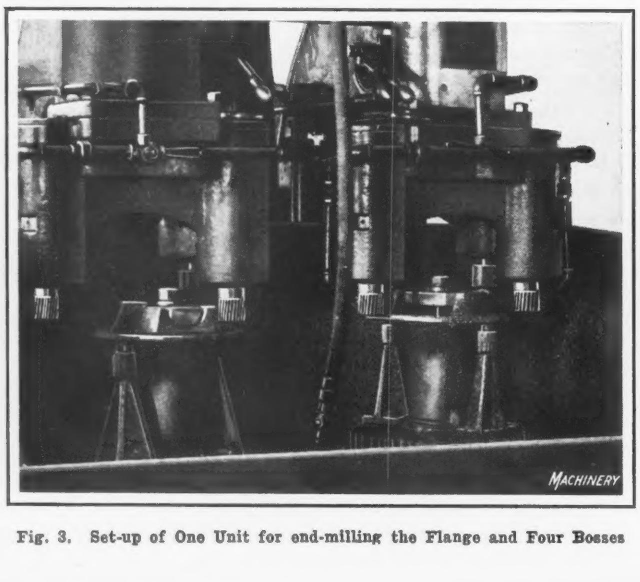


Fig. 3. Set-up of One Unit for end-milling the Flange and Four Bosses

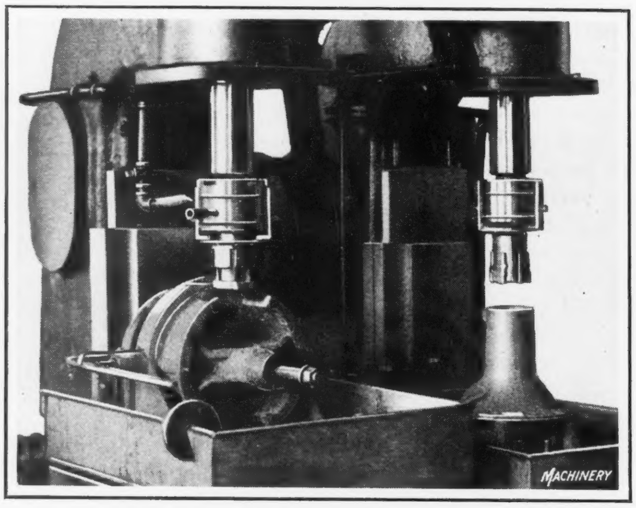


Fig. 4. Fixtures and Tools used in Tapping Operations on the Carrier

The third unit is used to tap simultaneously four ½-inch holes *F*, the table being entirely stationary in this case and the taps fed into the work by means of a mechanism in the special head provided. The taps are reversed and stopped automatically. The right-hand side of this unit is employed to spot-face ten bosses *J* for holes *E*. Rough- and finish-boring of the cross-bores *K* are accomplished by equipping the left-hand side of the fourth unit with a boring-bar and holding the work on an indexing fixture, while the right-hand side of this unit is used for finish-reaming surfaces *A*, *B*, and *C*, and reaming dowel-holes *I*.

Fig. 4 shows the set-up of the fifth unit, which is employed for tapping cross-bores *K* and surface *B* of the pinion bore. Both of these are tapped about 3½ inches in diameter and with sixteen threads per inch by the use of collapsible taps. The tables are fed by means of the cams at a rate corresponding to the lead of the threads, and so the correct lead is insured. The left-hand side of this unit is also equipped with an indexing fixture to provide for tapping the cross-bore on each side of the part.

BAKER BROTHERS ROTARY MACHINE

Competition in industry demands the attainment of maximum efficiency from the men, machinery, tools, and floor space. In plants where there are large quantities of parts requiring such operations as drilling, reaming, boring, counterboring, and spot-facing, it is common practice to group machines into batteries, so that one operator may set up work for several spindles, but with this arrangement, the operator loses time in moving from machine to machine. With the thought in mind of eliminating this loss of time and of conserving floor space, Baker Bros., Toledo, Ohio, have designed the No. 123 rotary drilling and boring machine here illustrated.

Machines of this type are built with either six or eight spindles, according to the requirements of the work. A man assigned to run a machine remains at the loading station, and as the successive spindles come to him, he removes the finished piece of work, sets up a fresh blank, and re-engages the feed. Change-gears provide for regulating the speed at which the spindles are carried around the circuit, so that sufficient time will be allowed for the operator to exchange blanks for finished pieces, and the time of the operation is such as to permit maximum efficiency from the tools.

The entire operating part of the machine, comprising six or eight drilling spindles and work-tables on a column, is suspended from a conical bronze bearing at the top of a central post, about which the machine rotates continuously. The operation on a part starts as the feed of a spindle is engaged, and is completed by the time that this spindle

gets back to the loading position. As a result, on a six-spindle machine, six pieces are finished at each revolution, and on an eight-spindle machine, eight pieces at each revolution.

There are two main sections of the power-transmitting mechanism; one of these provides for rotation about the central post, and the other supplies power to drive and feed the spindles. The arrangement of these drives is diagrammatically shown in Fig. 2. Gear *A* is connected to an individual motor drive, and drives shaft *E*. Power for rotating the outer frame of the machine is delivered from this shaft through spur gears *B* and through a set of change-gears *C*, which may be either plain or compound. By means of these change-gears the speed at which the machine rotates may be varied to meet the requirements of individual jobs. From the change-gears power is delivered through worm-gearing *D* to a vertical shaft on which there is a pinion that meshes with a bull gear at the base of the outer frame. A bearing of large diameter at the base serves as a lateral guide.

Shaft *E* runs through the machine and carries one of a pair of change-gears *F*, which may be of any required ratio. From its mating gear, the drive is through a pair of bevel gears *G* to a vertical shaft, at the top of which there is a spur gear that meshes with a set of six or eight gears, depending on the number of spindles on the machine. Each of these gears is mounted on a vertical shaft from which power is transmitted through bevel gears to an independent feed and speed mechanism for each spindle. As each of the drilling machine units on this rotary machine is the same as the No. 121 single-spindle machine built by Baker Bros., which was described in October, 1921, MACHINERY, it is unnecessary to describe the speed and feed mechanisms in detail.

Each spindle unit is independent of the others, so the machine as a whole can be operated satisfactorily with one or more spindles out of commission, should this be desirable. To stop any of the spindles, it is merely necessary to shift the speed-change lever of that unit to the neutral position. By having the speeds and feeds of each unit independent of the others, two or more operations can be performed on a given piece of work or on separate pieces in which holes of different sizes are required. The greatest savings in production cost are likely to be effected on work where the time required to complete the cut is of considerable duration.

It has been stated that the machine was designed to increase production rates on certain classes of work. As an example, the builders of the machine cite the case of a chrome-vanadium steel automobile transmission gear in which a one-inch hole, 3½ inches deep, is rough-drilled. This job was formerly handled on a gang of three Baker Bros. No. 121 single-spindle machines, tended by one operator, and the average production was 40 holes per hour. A six-spindle rotary machine built for this job gives a production of 120 holes per hour—an increase of 200 per cent. In addition, the drills are working at a slower speed and a finer feed, with the result that there is a longer period between grindings of the tools. There is also a saving in floor space of approximately 50 per cent.

An analysis of the working conditions on the battery of single-spindle machines and of the rotary machine shows just how these savings are accomplished. On the single-spindle machines two minutes was required for drilling each hole, and in one complete revolution of the rotary machine, which is made every three minutes, six holes are drilled. Each spindle drills for 2.5 minutes, and 0.5 minute is allowed for chucking the work and re-engaging the feed. On the single-spindle machines the time allowed for chucking and re-engaging the feed was only 0.3 minute. Thus the time of drilling on the single-spindle battery was less and the loading time less, but nevertheless, a much higher production is obtained with the rotary machine.

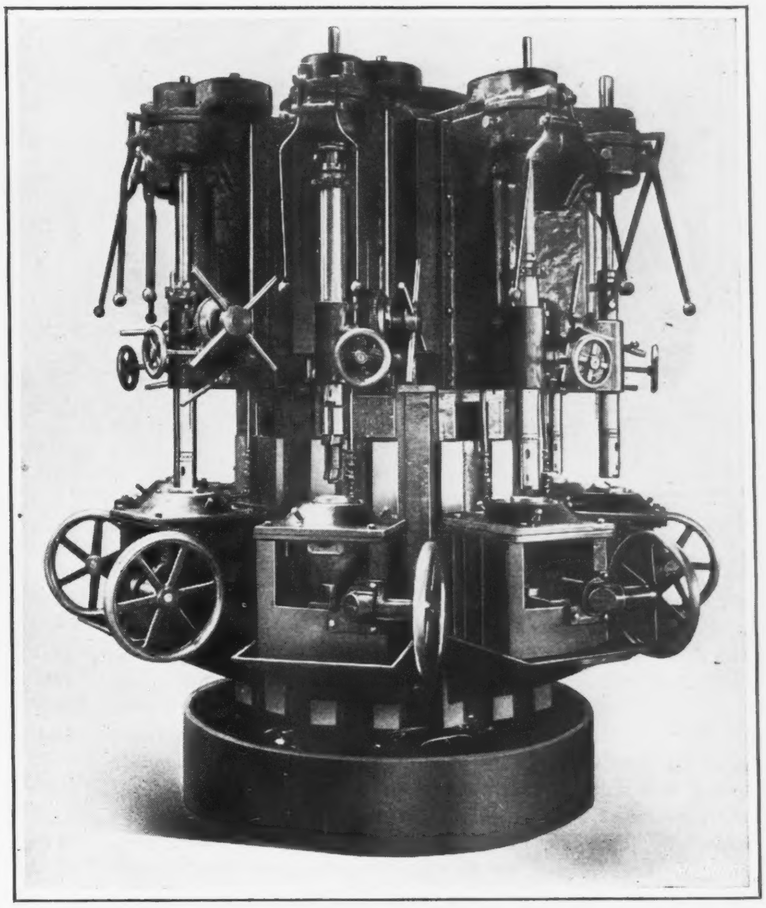


Fig. 1. Baker Bros. Rotary Drilling and Boring Machine

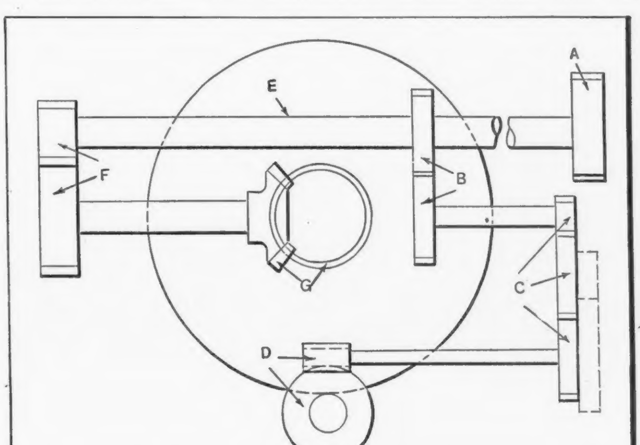
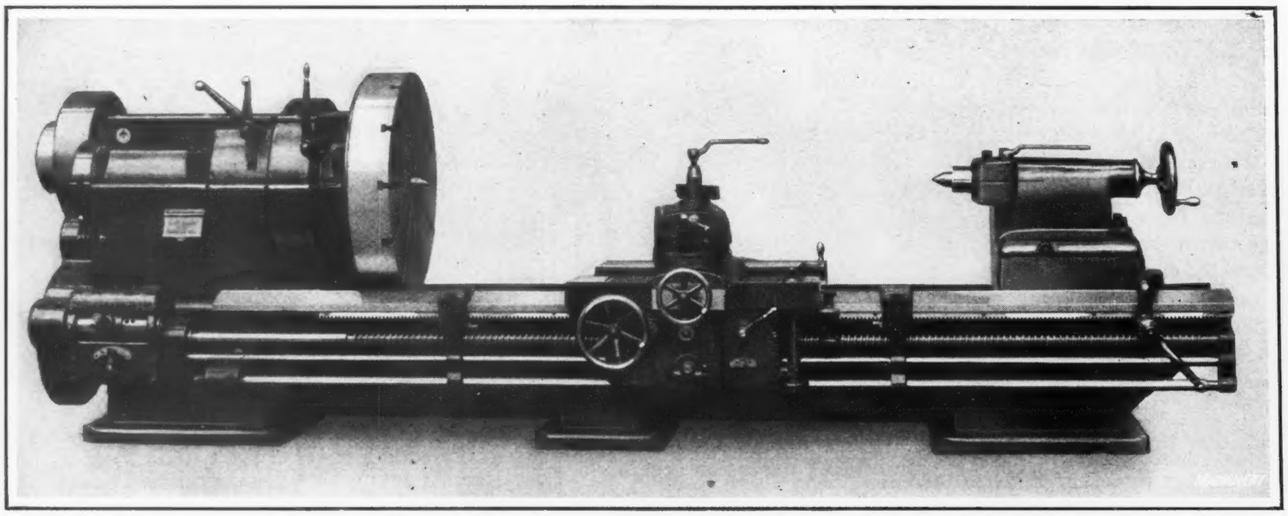


Fig. 2. Arrangement of the Drive on the Rotary Drilling and Boring Machine

LEBLOND HEAVY-DUTY GEARED-HEAD LATHES

Two new sizes of machines—30 and 36 inches—have been recently added to the line of single-pulley heavy-duty geared-head lathes built by the R. K. LeBlond Machine Tool Co., Cincinnati, Ohio. These machines embody the features of the 25- and 27-inch sizes described in January MACHINERY, but are considerably larger. Attention is called particularly to the selective-speed geared headstock on the 36-inch heavy-duty machine illustrated. This headstock is made with a faceplate drive, an external flanged steel ring-gear being rigidly mounted on the back of the faceplate. The driving pinion is made of a chrome-nickel alloy steel, heat-treated and hardened, and the teeth are of stub form and rounded



LeBlond Heavy-duty Geared-head Lathe

to insure adequate driving power and an easy sliding engagement.

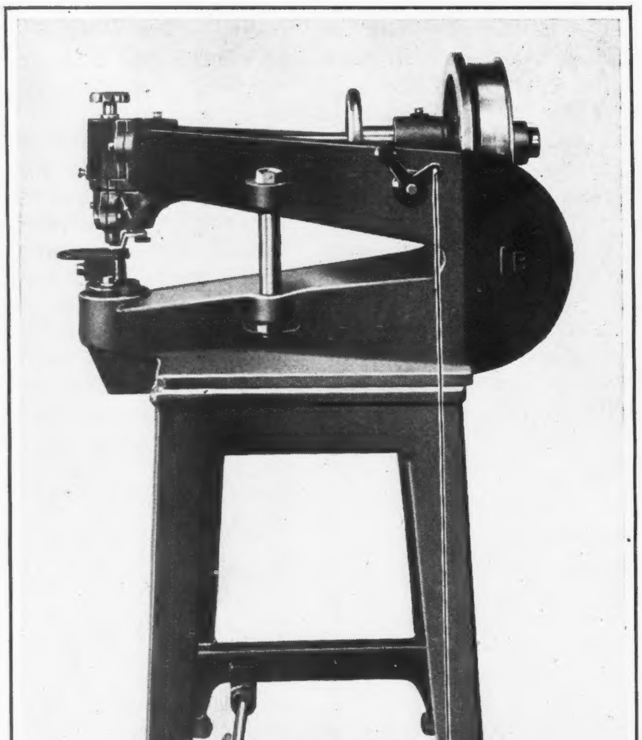
On the 36-inch selective-speed geared-head engine lathe the headstock is of the standard single-pulley drive construction, without the faceplate drive. The spindle face gear is of the same size, pitch, and face as the ring-gear of the faceplate drive construction, the essential difference between the two headstocks being that on the faceplate drive, the spindle face gear is transposed to the back of the faceplate. The faceplate drive construction is said to be especially desirable in taking exceptionally heavy turning cuts on large diameters, as the drive is direct to the faceplate, close to the point of tool pressure, and relieves the spindle of torsional strains.

In addition to the faceplate drive construction, the new headstock embodies all the features incorporated in the smaller headstocks on lathes previously described, including the multiple-disk driving clutch; multiple-spline shaft construction; sliding gears of chrome-nickel alloy steel, heat-treated and hardened; and automatic flooded lubrication. The other units of these larger lathes are identical in general design with those of the smaller lathes, but of increased proportions to insure rigidity and strength.

There are sixteen spindle speeds in geometrical progression from 4 to 255 revolutions per minute, the driving pulley running at a constant speed of 500 revolutions per minute. Forty-eight threads and feeds are obtainable, the thread range being from 3/4 to 46 per inch, and the feed range from 3 to 184 cuts per inch. The lathes may be driven by belt from a motor mounted on a hinged plate attached to the base of the machine, or there may be a geared motor drive from a motor mounted on top of the headstock, in which case the drive is through a motor pinion and a bakelite intermediate gear to a broad-faced gear that replaces the driving pulley. On the 36-inch machine, the swing over the shears is 38 1/2 inches; over the carriage, 29 inches; and over the compound rest, 26 5/8 inches; while the distance between centers on a 12-foot bed is 4 feet 7 inches. On the 30-inch machine, the swing over the shears is 32 1/2 inches; over the carriage, 22 1/4 inches; over the compound rest, 20 1/4 inches; while the distance between centers on a 10-foot bed is 2 feet 10 inches.

CAMPBELL NIBBLING MACHINES

Two nibbling machines are being introduced to the trade by Andrew C. Campbell, Inc., Bridgeport, Conn., which operate on the same principle as the 6-inch machine built by this concern, which was described in November, 1922, MACHINERY. The essential feature of these machines is their ability to cut the sheet stock to any scribed outline or templet. The machines consist essentially of an overhanging arm, which carries a rapidly reciprocating punch that operates above a female die supported by the bed-plate. The feed is governed by a stop-pin at the lower end of the punch, the stock being fed against this pin and a small portion cut away at each stroke of the punch. This arrangement permits cutting in any direction.



Campbell Nibbling Machine with Deep Throat

The No. 1-B machine is essentially the same as the older 6-inch machine, except that it has a 24-inch throat that enables larger sheets to be handled. This machine requires approximately 1/2 horsepower for cutting 3/16-inch stock, which is the maximum size that can be handled. The No. 2 machine is heavier, and cuts material up to 3/8 inch thick, requiring 1 horsepower for the maximum cutting. This nibbler attracted considerable attention at the recent New Haven machine tool exhibit due to its ability to cut screw machine cams rapidly. A five-lobe cam 3/8 inch thick was produced in one minute fifty seconds, and but a small amount of filing was required to bring it to the desired finish before hardening.

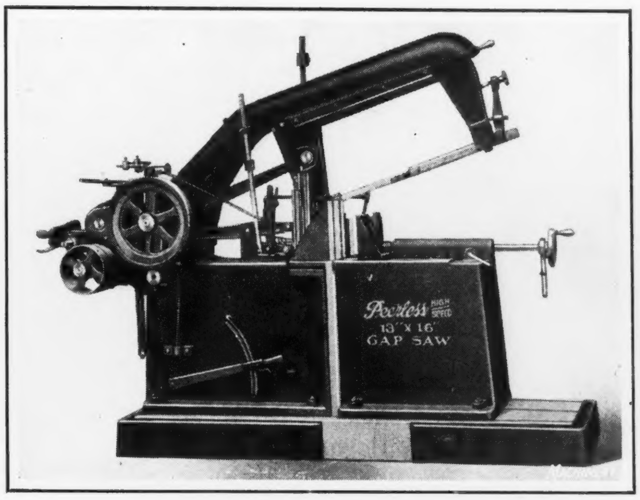


Fig. 1. Peerless High-speed Gap Saw with the Gap closed

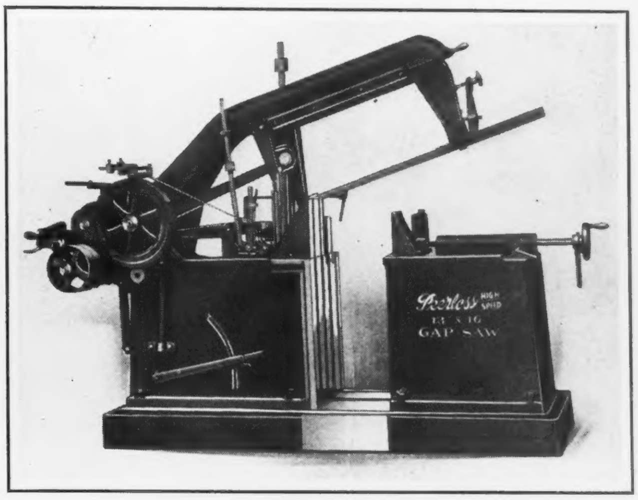


Fig. 2. Gap Saw with the Gap open to increase the Capacity

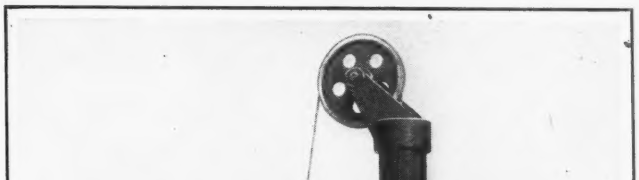
PEERLESS GAP SAW

A type of power hacksaw, called by the manufacturer a "gap saw," has been brought out by the Peerless Machine Co., 1611 Racine St., Racine, Wis. As in the case of a gap lathe, when the gap is closed, as shown in Fig. 1, the saw can only be used for ordinary purposes, and the capacity under this condition is 13 by 16 inches; but when the gap is open, as illustrated in Fig. 2, the saw has an excess work-holding capacity of 24 inches in height and 16 inches in width. A piece of steel, 16 to 26 inches, can, of course, be sawed in two by sawing to a depth of 13 inches and then meeting the cut by turning the piece half way around and taking a second cut to a similar depth. Work can be clamped either to the finished vertical face af the bed or to the base, as there are T-slots in both surfaces. A finished pad is provided on each side of the base opposite the gap for the convenience of the operator when locating work to be clamped to the base. The left-hand edge of the bed is also finished for convenience in measuring. A trough extends around the base to carry coolant to a reservoir, from which it is pumped up into a distributing pipe.

The head and feed mechanism is of the same construction as that used in the standard 13- by 16-inch high-speed saw built by the same company. The head is lifted on each return stroke, and when the blade comes to the bottom of the cut, the feed is automatically disengaged and the head lifted to its uppermost position by means of balance springs. The blade pressure or feed can be varied by raising or lowering a ratchet lever on the side of the head. The machine illustrated is equipped with the standard Peerless six-speed stroke mechanism, which provides different cutting speeds to suit the material being cut. The machine can also be furnished without this gear-box and with or without a motor drive.

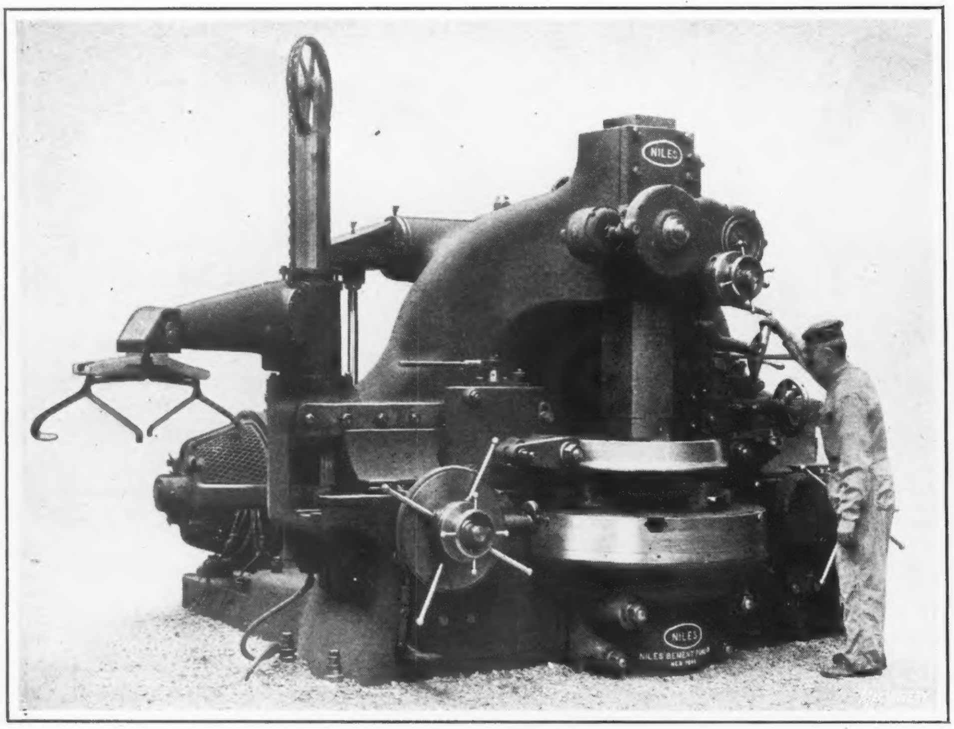
FOX "FLEXIBLE" POWER PRESS

A "flexible" power press in which the power is so applied as to be yielding, adapting the machine to straightening, pressing in bushings, broaching, and other operations of a similar nature, is being placed on the market by the Fox Machine Co., Jackson, Mich. The machine is at present built in 8- and 20-ton sizes. Speed of operation is one of the features, and another is the fact that it is possible to apply a pressure of one pound or of tons. After the work has been placed on the table, whether for straightening a bar or for pressing in a bushing, the operator depresses a foot-treadle, causing the ram to travel down at a rapid rate until it comes into contact with the work. From then on the pressure on the foot-treadle controls the travel of the ram and also the pressure applied to the work. When the foot-treadle is released, the ram is given a rapid upward travel by means of a heavy coil spring.



Fox Flexible Power Press for Straightening, Broaching, and Assembling Operations

Rotation of the ram is effected by means of a steel worm which drives a phosphor-bronze worm-gear secured to a long steel sleeve carrying two keys that fit splines in the ram. The entire drive is enclosed in a grease-case to insure adequate lubrication. The nose of the ram has a hardened steel thrust cap, and a special nose-piece is also provided so that a variety of form tools can be used in the end of the ram. The ram has a quadruple thread of coarse pitch, and the thrust is taken on a ball bearing. Some of the specifications of the 8-ton press are as follows: Maximum distance from nose of ram to table, 20 inches; stroke of ram, 18 inches; ram lead per revolution, 3 inches; ram travel, 155 inches per minute; distance from center of ram to face of column, 8½ inches; and weight, 3000 pounds. Similar specifications for the 20-ton press are as follows: Maximum distance from nose of ram to table, 20 inches;



Niles-Bement-Pond Vertical Car-wheel Lathe

stroke of ram, 18 inches; ram lead per revolution, 4 inches; ram travel, 128 inches per minute; distance from center of ram to face of column, 11 inches; and weight, 5000 pounds.

NILES-BEMENT-POND VERTICAL CAR-WHEEL LATHE

A vertical single-purpose machine tool has recently been brought out by the Niles-Bement-Pond Co., 111 Broadway, New York City, for machining rolled or forged-steel car wheels. This machine takes the wheels as they come from the hot-working operation, and turns the contour of the tread and flange, faces the hub and rim on one side (and also eccentric hubs where such exist), under-cuts the rim, and scribes the wear line. These cuts are taken by tools held in the vertical tool-bar and in the right- and left-hand side-heads. All the operations mentioned are accomplished simultaneously with the exception of the last, which is performed after the wheel has been finished. The machine is built in a number of sizes for handling wheels from 33 to 43 inches in diameter. It has maintained an output of 60 wheels per day, removing about 525 pounds of metal per hour.

From the illustration it will be seen that this vertical car-wheel lathe resembles a boring and turning mill, with the exception that there is no cross-rail. It is equipped with a horizontal rotary table and a long square tool-bar, which is adjustable vertically in the main housing. This bar carries a tool-holder with inserted blades which face off the hub and any eccentric hubs. A special motor supplies this bar with a power down-feed and a power traverse in both directions.

The main right-hand side-head is used to rough-turn the flange and tread, and this is also provided with a power feed. It carries an auxiliary tool-head in which are fitted tools to face and round the rim and under-cut it, and later scribe the wear line. There are cross and vertical hand adjustments for these tools. The left-hand side-head takes the finishing cut on both the flange and tread. This head is provided with a vertical hand adjustment and a power cross-feed. The feeds to all heads are independent of each other, and have automatic trips so that they may be disengaged at any predetermined point.

The main driving gear is a Maag-cut spur gear with a 12-inch face, and it is twice the diameter of the table. A variable-speed motor with a 3 to 1 range is direct-connected to the machine for driving it. A liberal supply of oil is assured at all necessary points for lubrication purposes. The table track and spindle run in a bath of oil, the lubricant flowing by gravity from a reservoir within the machine to the track and spindle, and then draining into a filter tank from which it is pumped back to the reservoir. The main driving gears are enclosed and run in oil, and all shaft bearings are equipped with sight-feed oilers.

The time for handling and setting up work is reduced to a minimum by means of the pneumatic crane with which the machine is equipped, patented pneumatically operated jaws that expand within the center hole of the wheel, and three serrated quick-acting driver dogs which support and drive the wheel on the table. A roller on the left-hand side-head, which is brought into contact with the wheel before chucking, serves to center the wheel in place for the operation.

OLIVER MOTOR-DRIVEN OILSTONE GRINDER

For sharpening turners, chisels, and tools, gouges, knives, irregular shaped edges, and similar work, in the pattern shop, the Oliver Machinery Co., Grand Rapids, Mich., is

Oliver Motor-driven Oilstone Tool Grinder which is also equipped with an Emery Cone and Wheel and a Leather Wheel

manufacturing the No. 585 motor-driven variety oilstone grinder here illustrated. This machine is equipped with two oilstone wheels, an emery wheel, an emery cone, and a leather stropping wheel. The oilstone wheels are kept constantly saturated with kerosene or other oil, which flows by capillary attraction and centrifugal force from the center of the stones to the outer surfaces, and thus keeps the pores free-cutting. The oilstone wheels are arranged with a table that serves as a tool-rest, and this table is equipped with a sliding tool-holder having a micrometer feed. Plane bits, chisels, and similar tools can be accurately ground by fastening them in this tool-holder.

The emery cone and leather stropping wheel are mounted directly on one end of the motor shaft. The cone is intended for sharpening the inside of curved edges, irregular shaped tools, etc., while the stropping wheel is employed for removing the burrs from tools and smooth cutting edges. The emery grinding wheel, which is intended for general utility, is mounted on the other end of the same shaft, and is equipped with an adjustable tool-rest. The arrangement of the machine is such that four operators may use it at one time. It is operated from a lamp socket, and may be moved from place to place. The oilstone wheels are 8 inches in diameter and 2 inches wide; the emery wheel, 8 inches in diameter and ½ inch wide; the emery cone, 3 inches in diameter at the large end, and 5 inches long; and the leather stropping wheel, 6 inches in diameter and 2 inches wide. The speed of the oilstone wheels is 300 revolutions per minute, and of the other wheels and cone, 1800 revolutions per minute.

EDLUND TILTED PRODUCTION DRILLING MACHINE

A new type of drilling machine intended for rapid drilling in production work and particularly suited for drilling small forgings or castings has recently been brought out by the Edlund Machinery Co., Inc., Cortland, N. Y. The only change that is required in adapting the machine to a new class of work is to provide the necessary work-holding devices on the rotary work-table and to change the feed gears and cams. The machine shown in the accompanying illustrations is equipped for drilling ⅜-inch holes in rim nuts of two lengths—9/16 and 11/16 inch. The production obtainable is 700 of the 11/16-inch nuts per hour, and 775 of the 9/16-inch nuts per hour. One operator can easily run two machines and generally three.

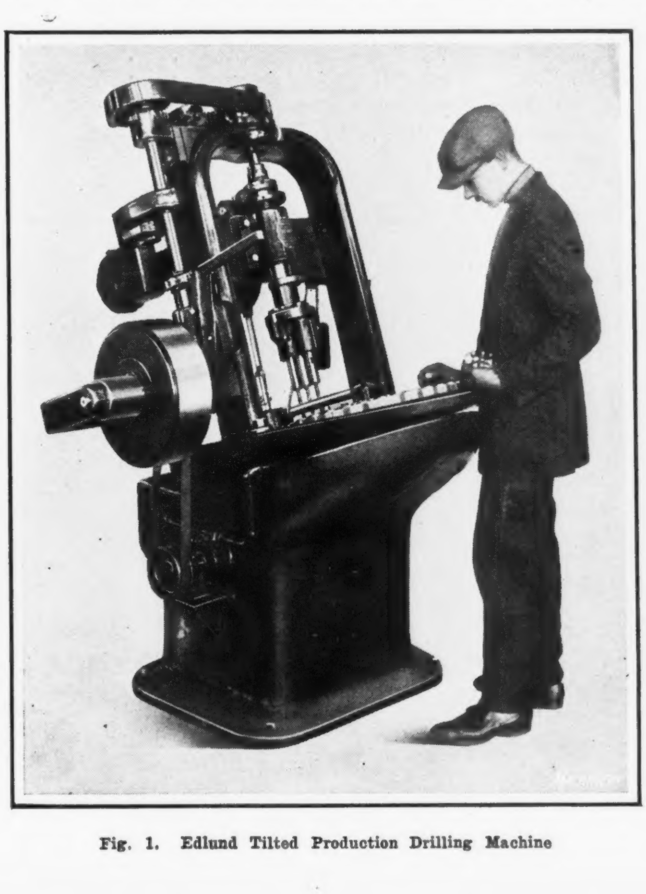


Fig. 1. Edlund Tilted Production Drilling Machine

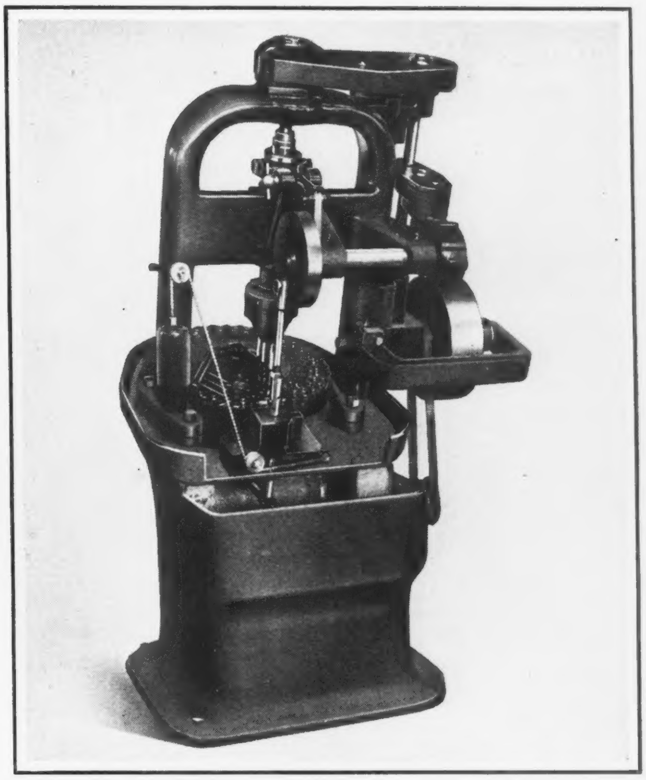


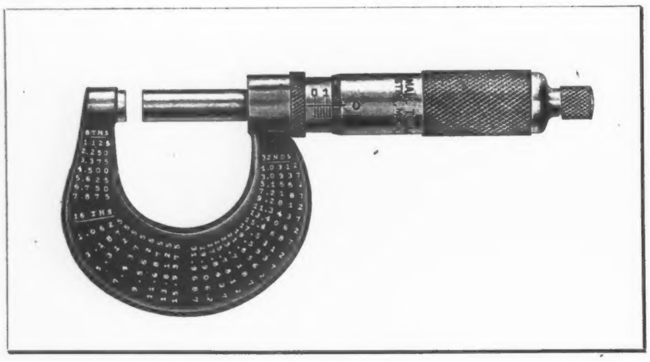
Fig. 2. Opposite Side of the Machine, showing the Method of carrying the Work

The work is carried in hardened steel bushings provided with hexagonal holes, the bushings being set in three rows in a steel ring that is indexed at each cycle of a feed-cam. Three nuts are drilled at each cam cycle by means of a three-spindle drill head. The indexing of the ring is accomplished by a pawl which operates in teeth cut around the periphery of the ring. The pawl is carried in a lever, the other end of which is operated by means of a flat cam. This cam also operates a positive ejector. The driving pulley is mounted on radial ball bearings and carries a bevel gear that meshes with another bevel gear mounted on a vertical driving shaft. This shaft is in two parts, connected by means of a square-tooth clutch that is operated through a lever located at the left of the operator. The clutch controls both the spindle rotation and the feed. Power is transmitted from the vertical driving shaft to the spindle through a silent chain.

The drill head has hardened steel gears, and is equipped with ball bearings throughout. The drive for the cam feed is taken from the vertical driving shaft above the clutch, as clearly seen in Fig. 2. It is possible to change the speed of the cam by changing two spur gears in the gear-case. A ball bearing is provided to take the thrust of a hardened steel worm which meshes with a worm-gear on the camshaft. A face-cam, which can be quickly changed, provides a positive return of the spindle.

REED MICROMETER CALIPER

A one-inch micrometer caliper with decimal equivalents on the frame is now being manufactured by the Reed Small Tool Works, Cherry and Vine Sts., Worcester, Mass. The figures are raised and afford a firmer grip on the micrometer, which is particularly advantageous when using it on oily work. All features of other Reed micrometers, such as the patented two-part thimble with instantaneous adjustment to compensate for wear on the anvil and spindle surfaces; the stationary anvil with narrow frame at the



Reed Micrometer Caliper with Decimal Equivalents on Frame

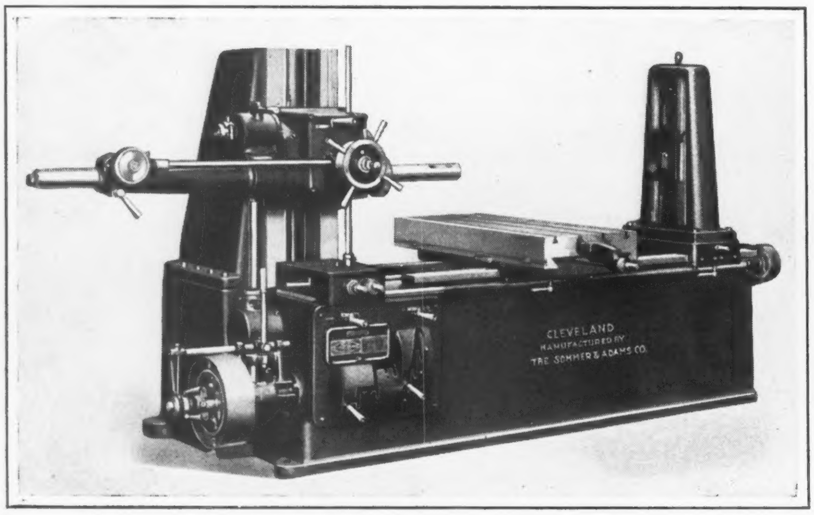
measuring point; and the threaded locked joint, which makes the thimble and spindle practically one piece are retained in the new tool.

The frame is drop-forged from steel, and then treated for a special finish, after which the decimal equivalents are raised in finishing dies subjected to about 500 tons pressure. Decimal equivalents of eighths, sixteenths and thirty-seconds of an inch are on the front of the frame, while equivalents of sixty-fourths of an inch are on the reverse side.

CLEVELAND HORIZONTAL BORING, DRILLING AND MILLING MACHINE

The horizontal boring, drilling and milling machine formerly built by the Cleveland Machine Tool Co. has been redesigned, and the improved machine is now being built by the Sommer & Adams Co., 18511-17 Euclid Ave., Cleveland, Ohio. The column of the new machine has been made heavier and provided with a wider base where it is attached to the bed. The bed is of the deep box type, and is heavily ribbed on the inside, so that a special base is unnecessary. The outer support has also been enlarged, and it can be clamped securely to the bed at any desired distance from the head or removed when not in use. The machine is equipped with a tapping attachment.

The drive is through a constant-speed pulley, for which a speed of 240 revolutions per minute is recommended. This speed gives twelve spindle speeds, ranging in geometrical progression from 10 to 150 revolutions per minute. The spindle sleeve is adjustable for wear from the outside, and has an integral faceplate for fastening large milling cutters, etc., for heavy work. The sleeve revolves in either a right- or a left-hand direction, and can be started, stopped, or reversed instantly by one lever. The spindle slides through the sleeve, having a power feed in either direction. It can be securely clamped for face-milling, and is controlled from the pilot wheel by means of a plunger for both a slow hand-feed and a quick traverse. There are vertical power feeds for the head; the platen has a power transverse feed in both directions, and the carriage a longitudinal feed.

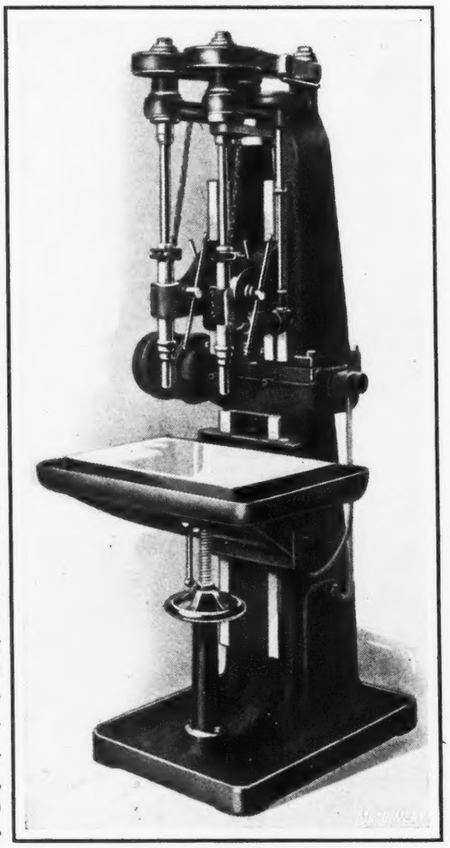


Cleveland Horizontal Boring, Drilling, and Milling Machine

A few of the important dimensions of this machine are as follows: Vertical adjustment of head on column, 18 inches; minimum and maximum distance from platen to spindle, ¾ inch, and 19 inches, respectively; maximum distance from faceplate to outer support, 5 feet; power transverse feed of platen, 30 inches; and longitudinal adjustment of saddle on bed, 36 inches.

HENRY AND WRIGHT "VIKTOR" DRILLING MACHINE

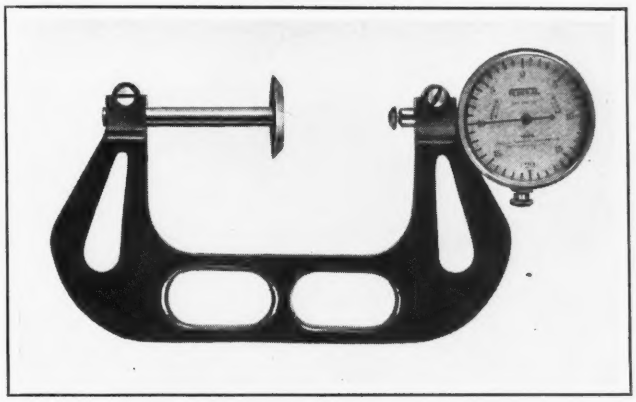
A direct motor-driven drilling machine of compact construction, which may be equipped with from one to eight spindles, is being introduced to the trade by the Henry & Wright Mfg. Co., 760 Windsor St., Hartford, Conn., under the trade name of "Viktor." This machine is designed to use drills up to ¾ inch in diameter. All mechanisms are enclosed to make the machine safe in operation. The standard power feeds are 0.004, 0.008, and 0.012 inch per spindle revolution, but by supplying suitable gears, finer feeds may be furnished, or coarser feeds up to 1/16 inch per spindle revolution. Four pairs of pulleys are furnished which give eight spindle speeds ranging from 339 to 2418 revolutions per minute. The motor is of one horsepower capacity, and runs at 1750 revolutions per minute. It is mounted on the side of the column as illustrated. Some of the important specifications of this machine are as follows: Distance between centers of spindles on multiple-spindle machines, 9 inches; maximum and minimum distance from table to spindle, 27½ and 0 inches, respectively; size of hole in lower end of spindle, No. 2 Morse taper; traverse of rack, 6½ inches; size of working surface of table, 16 inches square; and weight of machine, approximately 820 pounds.



Henry & Wright Drilling Machine

FEDERAL ROUND-STOCK GAGE

A gage equipped with a dial indicator and intended for gaging round stock up to 4 inches in diameter is shown in the accompanying illustration. This gage is a recent development of the Federal Products Cor-



Federal Gage equipped with a Dial Indicator

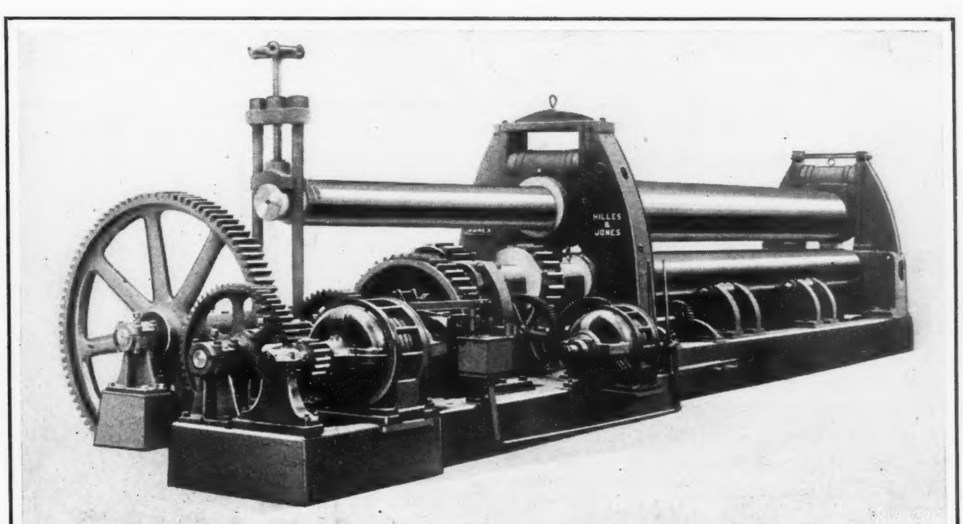
poration, 15 Elbow St., Providence, R. I. The anvil and the indicator point are both ground on the taper to provide for the easy insertion of the part to be gaged. By using the flat anvil, the center of the material can quickly be found as the small indicator point is passed over the center line.

HILLES & JONES BENDING ROLL

A large boiler-plate bending roll, designed for handling plates up to 1⅝ inches thick and rolling them to relatively small diameters, has been built by the Hilles & Jones plant of the Consolidated Machine Tool Corporation of America, Rochester, N. Y. This No. 9 bending roll is an improved heavy-duty hinged-housing machine. The distance between the housings is 26 feet 6 inches, which provides ample length for rolling plate 26 inches long. There are two interchangeable upper rolls, one of which is 36 inches in diameter, and the other 30 inches. The larger of these is used when rolling the heaviest plate to ordinary diameters, while the smaller roll is used when rolling plates to small diameters of about 36 inches. The lower rolls are each 22 inches in diameter. The rated capacity of this machine is 2,500,000 pounds, or 1250 tons, pressure.

The upper roll is supported from the roll necks, which are fitted in trunnions carried in yokes. The raising and lowering of this roll is accomplished through a worm and worm-wheel drive, which is so designed that both ends of the roll may be raised or lowered simultaneously, or one end held stationary while the other is raised or lowered. The latter arrangement is necessary for rolling plates to conical shapes, and is often found advantageous in ordinary boiler-shop practice.

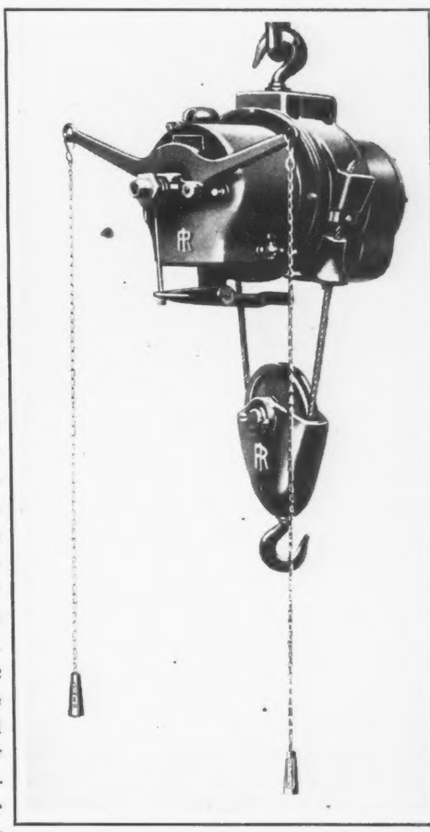
The machine is geared for two speeds—a slow speed for handling the heavier plates and a high speed for handling lighter ones. Control of the speeds is through hand-levers, which act directly on positive clutches. Two roller supports are provided for the lower rolls, and each of these carries four machined forged-steel rollers, which are held in closed-end bearings and lubricated by means of large grease cups. This arrangement not only insures lubrication, but also prevents scale and dirt from stopping the action of the rollers. A 125-horsepower motor is used for driving the lower rolls, and one of 60-horsepower capacity for raising and lowering the upper roll. The weight of the machine is about 415,000 pounds.



Hilles & Jones Bending Roll for Plates up to 1⅝ Inches Thick

INGERSOLL-RAND AIR HOIST

A small air hoist of 500 pounds capacity is being placed on the market by the Ingersoll-Rand Co., 11 Broadway, New York City. This size A hoist is shown in the accompanying illustration. The features claimed for it include compactness of design which reduces the necessary head room, relatively light weight, an automatic brake which holds the load under all circumstances even should the air supply be disconnected or fail, and a graduated throttle which permits a close regulation of both lifting and lowering speeds.



Ingersoll-Rand Air-motor Hoist

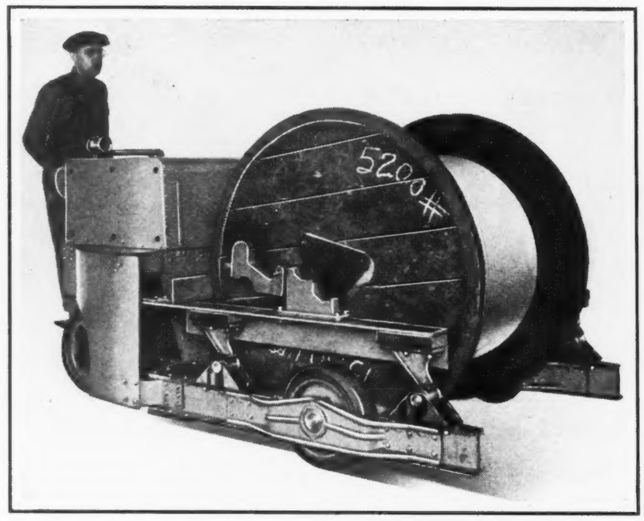
The hoist is equipped with a three-cylinder air motor which operates in either direction and is geared to a hoisting drum. A safety stop-lever is provided to close the throttle and stop the motor whenever the load is by chance raised to the top of the lift. The automatic brake holds the load at any desired position for any length of time, regardless of the air pressure. This brake consists of a disk attached to the motor shaft, and a brake plunger with a friction face that is held in contact with the disk by springs whenever the hoist is not operating—that is, whenever the air supply to the motor is cut off either by throttling or otherwise.

MERCURY TRACTOR

A type H industrial tractor equipped with an internal gear drive is built by the Mercury Mfg. Co., 4118 S. Halsted St., Chicago, Ill. Tests conducted by the manufacturers showed that at a draw-bar pull of 200 pounds, the new truck developed an efficiency about 23 per cent greater

than the worm-driven type L truck built by the same company. At a draw-bar pull of 600 pounds the efficiency was 28 per cent greater, and at 800 pounds, 40 per cent. The drive or "power plant" comprising the motor, motor hanger, rear axle housing, rear wheels, rear springs, and all driving gears, is assembled in a single unit which may be detached from the frame in five minutes. The drive from the motor is through a self-aligning spring coupler to a pinion which drives a bevel gear in the axle housing. This gear, in turn, drives axle pinions on each rear wheel, which transmit the power through three idler gears to a large ring gear mounted on the inside of the driving wheels.

The motor is of a high-speed series-wound type, and the coupling between it and the driving pinion consists of four coil springs that cushion the initial starting torque. The axle is of the full-floating type. With an 18 to 1 gear reduction, the truck has a normal draw-bar pull of 475 pounds, and a maximum pull of from 1700 to 1800 pounds, while with a 24 to 1 gear reduction, the normal draw-bar pull is 600 pounds and the maximum pull, from 2000 to 2100 pounds. The chassis without the battery weighs 1850 pounds.



Wire-reel Truck built by the Automatic Transportation Co.

Higgins Flexible Shaft Coupling made by the Tomkins-Johnson Co.

HIGGINS FLEXIBLE COUPLING

A flexible coupling which compensates for axial and angular misalignments of shafts, allows one or both shafts to move or oscillate endwise, and provides lubrication for the bearing surfaces, is manufactured by the Tomkins-Johnson Co., Jackson, Mich. This coupling has two duplicate members, each secured to the ends of the shafts. Each member has two driving lugs which engage slots in a middle member in such a way that misalignment of the shafts is impossible. The middle member floats on the lugs on the shaft members without cramping or binding in any way and without backlash. The middle member is made of a fibrous material which provides a slow and gradual seepage of oil through its pores from a central reservoir to the bearing surfaces between its slots and the lugs on the shaft members. The central reservoir may be refilled with oil after removing the small screws located on the outside of the middle member.

WIRE-REEL TRUCK

An electric truck for handling wire reels is a recent development of the Automatic Transportation Co., Inc., 2933-65 Main St., Buffalo, N. Y. This truck is equipped with two long lifting arms which lift the reel by means of a bar placed through the reel core. The span between the lifting arms is variable, and is determined by the general size of the reels to be handled. A device on each lifting arm known as a "set-up jack" enables the truck to handle any size of reels up to 84 inches in diameter.

The front wheels are rubber-tired and are equipped with Timken bearings. The raising mechanism consists of a separate motor and worm-gearing that is direct-connected to the lifting arms. The lifting is accomplished by means of members having inclined planes which, when raised, rest on a solid surface and take the entire strain from the lifting mechanism. The height of lifting is $4\frac{1}{2}$ inches. The power or propelling unit consists of a heavy-duty motor and controller that drives through worm-gearing. A circuit-breaker and interlocking device work in conjunction with the controller and brake, thus making it impossible to operate the truck when the driver is not in position. This truck is built in capacities of 6000 and 10,000 pounds.

HISEY-WOLF BALL-BEARING GRINDING MACHINE

An improved line of floor- and bench-type grinding machines, equipped with ball bearings, is being placed on the market by the Hisey-Wolf Machine Co., Cincinnati, Ohio. One important improvement incorporated in the new machines is the combination wheel guards, which are adjustable to any angle so that they may be set to meet all variations of work. Two side views of one of these guards are shown in Fig. 2, that at the left illustrating how the guard may be placed in an angular position. The view at the right shows the protection afforded by the guard after a 10-inch wheel has been worn down to 5 inches in diameter, the top of the guard being always nearest the wheel so as to serve as a spark and chip breaker. The adjustment for wear of the grinding wheel is made by moving the guard proper back on the support bracket. This guard is interchangeable with the standard open-type guard, and is fitted with a removable end cover and an exhaust pipe connection.

Another feature of these grinding machines is an automatic motor starter, the control button of which is located

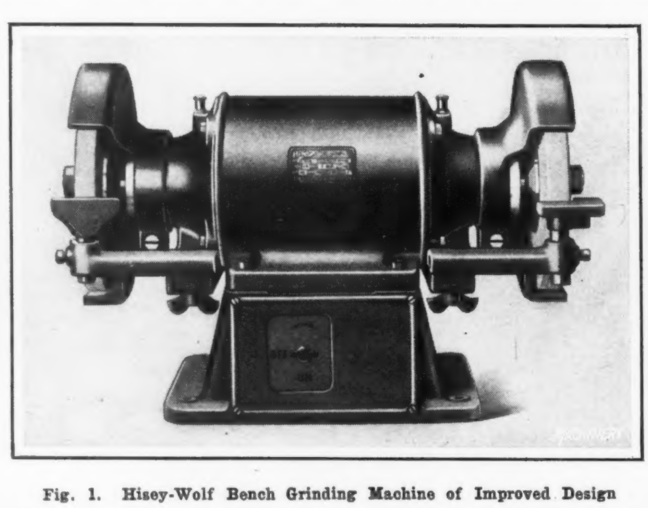


Fig. 1. Hisey-Wolf Bench Grinding Machine of Improved Design

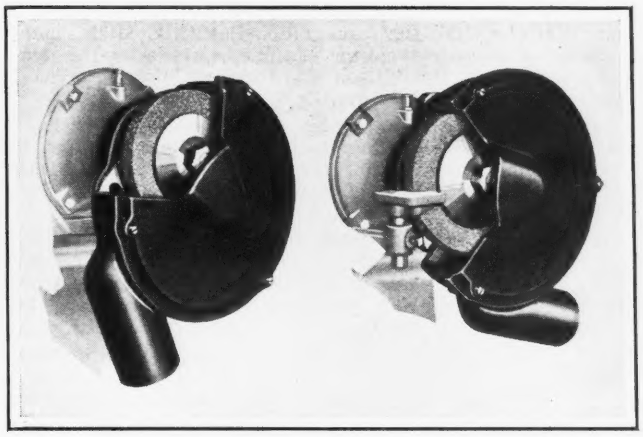


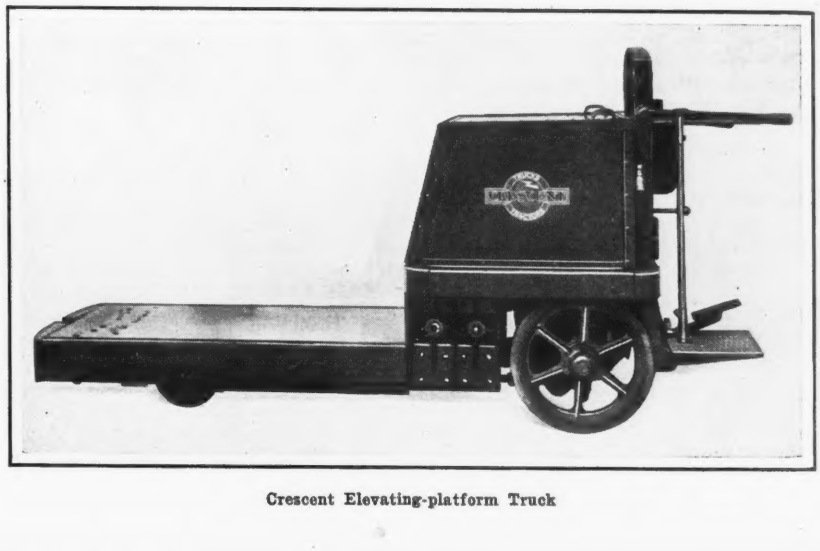
Fig. 2. Two Views showing the Manner in which the Guards may be adjusted

on the front of the machine, with the main part of the switch completely enclosed in the base. The switch mechanism is readily accessible by removing the cover plate. The bench grinders are made in two sizes, of ½ and 1 horsepower capacity, while the floorstand grinders are built in seven sizes, ranging from ½ to 10 horsepower capacity.

CRESCENT TRUCK AND TRACTOR

A type GEL elevating platform truck, shown in the accompanying illustration, and a type TT-23 four-wheel tractor are being placed on the market by the Crescent Truck Co., Lebanon, Pa. The platform of the truck is put under a loaded skid and then raised to lift the skid clear of the floor. Portable bins can also be handled in a similar manner. The truck platform can be raised 4½ inches by a power mechanism which is driven by a separate motor from that used for driving the truck. The platform can be raised while the truck is in motion. The drive consists of a hardened steel worm which meshes with a bronze worm-wheel, a four-pinion bevel-gear differential, and full-floating chrome-nickel steel axle shafts. Self-aligning ball bearings are provided in this drive. The truck can carry a load of 4000 pounds, and travels at a speed of from 4½ to 5 miles per hour when carrying the rated load. It has a two-wheel drive and a four-wheel steer.

The four-wheel tractor is designed to do somewhat heavier work than the three-wheel tractor built by this company. It is equipped with heavy steel bumpers on the front and rear, and may be used for pulling loads on trailers or pushing or pulling machines and other weighty objects into the desired position. The drive is similar to that of the truck.

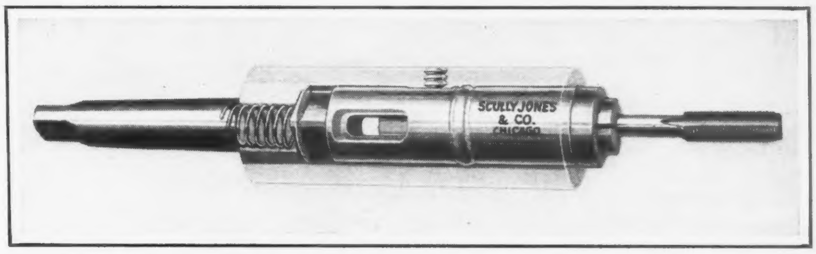


Crescent Elevating-platform Truck

The tractor is also equipped with solid rubber tire wheels. It has a normal draw-bar pull of 600 pounds, and an ultimate draw-bar pull of 2400 pounds, and travels at a speed of from 5 to 6 miles per hour under load.

VAN DORN ELECTRIC GLUE POT

A water-jacketed electrically heated glue pot with a thermostatic control for keeping the glue at the proper working temperature has been brought out by the Van Dorn Electric Tool Co., Cleveland, Ohio. The glue pot is an aluminum casting of two-quart capacity, and has a rim machined to provide an air-tight fit on the water pot. The outside of the latter telescopes over a rim on the base to prevent the penetration of water to the heating element when refilling the pot. The heating element is a nichrome ribbon, insulated by mica plates, and is moisture-proof. A crowned base presses the heating element solidly against the bottom of the water pot to insure a thermal contact without loss of heat. An asbestos plate and an air chamber in the base add to the heat insulation and obviate any loss of radiation downward. The thermostatic control keeps the temperature of the glue pot contents at 150 degrees F.



Scully-Jones Spring-compression Tap Chuck Holder with Floating Action

SCULLY-JONES TAP CHUCK HOLDER

The spring-compression tap chuck holder here illustrated is a recent product of Scully-Jones & Co., 13th and Robey Sts., Chicago, Ill. A feature claimed for the holder is that it permits taps to start threading while under a spring pressure without losing the positive drive feature of the "Wear-Ever" tap chucks made by this concern. This chuck is recommended for multiple-spindle work, irregularities in the alignment of the spindles and the work being compensated for by the floating action. The amount of compression is sufficient to permit the simultaneous use of taps with slight variations in lead. This holder is made in four sizes, with Nos. 1 to 5 Morse taper shanks.

* * *

A committee appointed by the U. S. Chamber of Commerce to study the subject of transportation, has reported that the motor truck is more of an aid or feeder of the railroads than a competitor. The National Industrial Conference Board, on the other hand, has stated that many of the smaller railroads and their branches have been so hurt by competition with motor trucks and bus lines that their financial position is seriously threatened. The importance of a railroad system in a good financial position, apart from the importance of its providing adequate traffic facilities, is evidenced by the fact that in 1922 the railroads spent for materials and supplies alone, for general operation, not less than $1,668,000,000. Directly, the railroads consumed between 12 and 15 per cent of the iron and steel output; and indirectly, through their orders for equipment and supplies from the industries, 30 per cent. They consumed 10 per cent of the copper and brass produced.

NEW MACHINERY AND TOOLS NOTES

Bending Machine: Amplex, Inc., 6 W. 32nd St., New York City. A machine designed for bending angle-irons cold, which is built in six sizes for work from 2¼ by 2¼ by 5/16 inch to 8 by 8 by 1 inch, with the legs out. It will also roll angle-irons with the legs in, but in this work the capacity is for angle-irons of smaller sizes. I-beams and channel irons ranging from 3 to 12 inches may also be bent, as well as flat, round, and square stock. The smallest diameter to which work can be rolled is 24 and 60 inches in the smallest and largest machines, respectively.

Automatic Chucking Machine: Goss and De Leeuw Machine Co., New Britain, Conn. An automatic chucking machine equipped with four work-spindles for turning, boring, facing, threading, and reaming work up to 6 inches in diameter and 6¾ inches in length. A work turret is carried to and from the tools by the action of a cam, the turret being indexed by an automatic mechanism. A wide range of speeds and feeds is available through change-gears. In threading operations, taps and dies are fed in a positive manner by lead-screws of the same pitch as the thread being cut, and both inside and outside threads of the same or different pitch may be cut at the same time. The threading spindle has a reversing action which permits the operator to throw out the feed at any time, even during the threading operation, without damage to the machine or tap.

Static-Dynamic Balancing Machines: Tinius Olsen Testing Machine Co., 500 N. 12th St., Philadelphia, Pa. A line of Olsen-Carwen static-dynamic balancing machines for balancing rotors up to 100,000 pounds in weight or greater. These machines indicate the amount of unbalance statically and dynamically differentiating between the two, and also indicate the existence of a dynamic couple and the location of the static unbalance along the length of the rotor, all without stopping the machine. The part to be balanced is mounted in plain bearings which are bolted to a vibrating bed supported on springs. The part being balanced is connected to a driving head that revolves it at a critical speed, depending upon the mass and the spring suspension; if the part is balanced under this speed, it will be balanced at any speed. The amount of static and dynamic unbalance is determined in ounce-inches.

* * *

PERSONALS

Colonel J. B. Dillard, formerly assistant superintendent of the Cleveland Twist Drill Co., Cleveland, Ohio, has been appointed general superintendent.

Benjamin Soby has been appointed assistant to the manager of the Promotion of Sales Department of the Westinghouse Electric International Co., East Pittsburg, Pa.

W. H. Haines, formerly chief inspector of the Schenectady Works of the General Electric Co., has retired, and has been succeeded by W. W. Wagner as chief inspector of that plant.

Walter V. Lawton has been appointed district manager of the Boston district of Manning, Maxwell & Moore, Inc., with headquarters at the Textile Building, 99 Chauncy St., Boston, Mass.

Frank R. Taylor, formerly with the manufacturing department of the Addressograph Co., Chicago, Ill., has joined the sales force of the Stocker-Rumely-Wachs Co., 117 N. Jefferson St., Chicago, Ill., a machine tool dealer.

Milton C. Fidgeon, who for years has been a member of the machinery and steel organization of Joseph T. Ryerson & Son, Inc., Chicago, Ill., has just been appointed eastern machinery sales manager, with office at 30 Church St., New York City.

Walter S. Bronk, for a number of years connected with the Badger-Packard Machinery Co., Milwaukee, Wis., and for the last two years manager of the Milwaukee Machinery Co., has resigned his position as manager and director of the latter company.

Blake D. Hay has been appointed district manager of the Williams Tool Corporation at Chicago. Mr. Hay has been connected with the corporation for some time at its factory in Erie, Pa. He succeeds Hugo E. L. Mey in charge of the Chicago branch office and territory.

Joseph Wainwright has been appointed sales manager and W. C. Chapman has been appointed district manager of the Philadelphia district of Manning, Maxwell & Moore, Inc., with headquarters at the Pennsylvania Building, 15th and Chestnut Sts., Philadelphia, Pa.

Ralph E. Flanders, manager of the Jones & Lamson Machine Co., Springfield, Vt., and president of the National Machine Tool Builders' Association, has been elected a delegate of the American Society of Mechanical Engineers to the American Engineering Council.

H. A. Wilson has been appointed manager of the Detroit branch of the Gibb Instrument Co., Bay City, Mich., manufacturer of electric welding equipment, to take the place of F. M. Luchs. Mr. Wilson was formerly district manager in New York for A. P. Munning & Co.

James L. Gough, for many years associated with the machine tool industry, has become sales manager for the Stocker-Rumely-Wachs Co., 117 N. Jefferson St., Chicago, Ill., machine tool dealer. Mr. Gough had been out of business for some time on account of poor health.

N. S. Bates, who has been connected with the Pratt & Whitney Co., Hartford, Conn., since 1902, having recently held the position of superintendent of equipment, has joined the organization of the Hartford Special Machinery Co., Hartford, Conn., in the capacity of factory manager.

Guy E. Tripp, chairman of the board of the Westinghouse Electric & Mfg. Co., and Loyall A. Osborne, president of the Westinghouse International Co., sailed for Japan from San Francisco, October 10, on the S. S. *Shinyo Maru*. They will also visit Shanghai, Hongkong, Pekin, and the Philippines before returning to the United States.

Nelson Littell, formerly second assistant examiner in the United States Patent Office, has recently resigned to engage in the practice of patent law, with offices at 110 E. 42nd St., New York City. Since August, 1919, Mr. Littell has examined applications for patents in metallurgical and mechanical lines, in Division 3 of the Patent Office.

Richard W. Yerkes, formerly general manager of the Link-Belt Co.'s Philadelphia plant, has been appointed treasurer of the Link-Belt Co., with headquarters at the general offices, 910 S. Michigan Ave., Chicago, Ill., succeeding B. A. Gayman. Mr. Gayman has been made president of the newly acquired Meese & Gottfried Co. of San Francisco.

Charles M. Brown was elected president of the Colonial Steel Co., Pittsburg, Pa., at the last annual meeting. Herbert C. Poole, who has been in charge of the New York office of the company for the last thirteen years, was appointed general works manager, and Jacob Trautman, Jr., who has been assistant sales manager, was appointed general sales manager.

Edgar Bloxham of Paris, France, representing among other firms Sleeper & Hartley, Inc., Worcester, Mass., is in the United States at the present time, having come here with a view to placing orders for equipment of various kinds. Mr. Bloxham states that the prospects at present for American equipment and tools of special or highly developed types in France are very good.

Walter V. Houck has been appointed sales engineer for Crane-Schiefer-Owens, Inc., and will be located at the home office, 501 Morgan Bldg., Buffalo, N. Y. Mr. Houck has previously served as chief engineer and production manager of the King Sewing Machine Co., works manager of the Sterling Engine Co., and general manager of the Buffalo Metal Goods Co. when this plant was acquired by the General Motors Co.

James W. Hook, formerly president of the Allied Machinery Co. of America, was elected president and treasurer of the Geometric Tool Co., New Haven, Conn., at a recent meeting of the directors, to fill the position held for so many years by the late Howard E. Adt. Mr. Hook had become associated with the Geometric Tool Co. on October 1, in the capacity of vice-president and general manager, as mentioned in October Machinery.

W. E. Sykes, of the Power Plant Co., Ltd., West Drayton, England, has come to this country to join the staff of the Farrel Foundry & Machine Co., Buffalo, N. Y., as consulting engineer. Mr. Sykes is recognized as an authority on the subject of gearing, and is known as the inventor and designer of the Sykes gear generator. He spent seven months last winter in the United States, and so is acquainted with American practice in engineering and business.

Mortimer E. Cooley, dean of the College of Engineering and Architecture of the University of Michigan, has resigned the position of president of the American Engineering Council of the Federated American Engineering Societies on account of ill health. Mr. Cooley succeeded Herbert Hoover as president two years ago. His successor will be chosen at the annual meeting of the American Engineering Council in Washington, D. C., early in January.

Arthur Jackson, who represented the Potter & Johnston Machine Co., Pawtucket, R. I., in Japan, has arrived with his wife in the United States, having safely escaped the terrible consequences of the earthquake. Mr. Jackson was in Tokyo at the time of the earthquake and both he and his wife had a miraculous escape. He states that Japan will be likely to be in the market soon for every type of machine tool, and it seems probable that the factories at Osaka, Kyoto and Kobe will be very active for a long period to come.

TRADE NOTES

GWILLIAM Co., manufacturer of ball and roller bearings, has moved its New York branch from 253 W. 58th St. to the Brooklyn headquarters of the concern at 23 Flatbush Ave., Brooklyn, N. Y.

ROCKFORD MILLING MACHINE Co., Rockford, Ill., has appointed the Millholland Sales & Engineering Co., 540 Consolidated Bldg., Indianapolis, Ind., exclusive distributor for Rockford millers and Sundstrand lathes in the state of Indiana.

CADILLAC MACHINERY Co., Detroit, Mich., has been appointed exclusive sales agent for the Grand Rapids grinding machine division of the Gallmeyer & Livingston Co., Grand Rapids, Mich., to cover the Detroit territory, which comprises the eastern half of Michigan.

DAVID BELL Co., INC., 1555-1557 Fillmore Ave., Buffalo, N. Y., has been incorporated by David Bell, former owner of the BELL Co. The company will continue to manufacture screw machine products, both on automatic and hand screw machines, and heat-treated steel products.

CHICAGO PNEUMATIC TOOL Co., 6 E. 44th St., New York City, has taken over the exclusive sale of all the products of the Crescent Pump Co., Detroit, Mich., and in the future will handle all inquiries regarding the roto-piston vacuum pumps, roto-piston pressure blowers, and vacuum chucks made by that company.

WESTINGHOUSE ELECTRIC INTERNATIONAL Co., East Pittsburg, Pa., has received orders for electrical apparatus to be used in reconstruction work in Japan, totalling over a million dollars. It is understood that the power plants in the earthquake zone were not seriously damaged but that the distribution systems were practically destroyed.

BUCKEYE TWIST DRILL Co., Alliance, Ohio, and GARDNER TAP & DIE Co., Cleveland, Ohio, have placed T. J. Davis in charge of the Chicago territory for the sale of these companies' products, with headquarters at 542 W. Washington Blvd., Chicago, Ill. A complete line of drills, reamers, and taps will be carried in stock at the Chicago store.

VAN NORMAN MACHINE TOOL Co., Springfield, Mass., manufacturer of Van Norman and Franklin milling and grinding machines, has appointed A. C. Lindholm its permanent representative on the Pacific Coast. Mr. Lindholm was formerly general manager of the Franklin Machine & Tool Co., which was recently merged with the Van Norman Machine Tool Co.

LANDIS TOOL Co., Waynesboro, Pa., has purchased all the patents, patterns, jigs, etc., for the Oakley cutter and reamer grinder built by the Oakley Machine Tool Co., of Cincinnati, Ohio. This machine will now be manufactured solely by the Landis Tool Co., and will be known as the Landis cutter and reamer grinder. It will be made in sizes corresponding to the Nos. 1, 2, and 3 Oakley machines.

LOGEMANN BROS. Co., Milwaukee, Wis., manufacturer of baling and scrap metal presses, has purchased the business, patents, and good will of the CHICAGO BALING PRESS MFG. Co., Chicago, Ill., and in addition to its regular line of hand-operated power-driven and hydraulic balers, is now prepared to furnish the Logemann "Modern Leader" balers and repair parts formerly manufactured by the latter organization.

SELFLOCK NUT & BOLT Co., INC., East Syracuse, N. Y., manufacturer of friction fit nuts and bolts, has entered into a contract with the Bethlehem Steel Co., Bethlehem, Pa., for the manufacture and sale of carriage and machine bolts, track bolts, and heavy railway nuts and bolts. The Selflock Co. will increase its facilities and specialize on S.A.E. Selflock products, as well as cap-screws with Selflock threads.

SIMONDS SAW & STEEL Co., Fitchburg, Mass., manufacturer of saws, knives, files, and steel, announces that the prizes of $1000 and $500 offered by Alvan T. Simonds, president of the company, for the two best essays on the subject "The Lack of Economic Intelligence" open to students in high schools, trade schools and normal schools, have been won by John J. Borchardt and Morris Saltzman, both of Brooklyn, N. Y.

RAMSEY CHAIN Co., INC., 1031 Broadway, Albany, N. Y., has been incorporated under the laws of the state of New York, and has taken over the assets and liabilities of the ALBANY MACHINE & TOOL Co. Hereafter all business of both companies will be transacted under the name of Ramsey Chain Co., Inc. Anthony Brady Farrell is the president and treasurer, and Joseph H. Ramsey vice-president and secretary.

WESTINGHOUSE ELECTRIC & MFG. Co., East Pittsburg, Pa., has established a general engineering division at its South Philadelphia works, which will be devoted to the study of central station and industrial plant problems, involving the application of steam power apparatus, such as steam turbines, condensers, and reduction gears. This department will also cooperate with the sales organization in providing engineering service to purchasers of this equipment.

ROKU-ROKU SHOTEN, LTD., announces that its head offices in Tokio, Japan, were totally destroyed by the recent earthquake, and the company would like to obtain complete machine tool catalogues and price lists to replace its files. Temporary headquarters have been established in Tokio, care of S. Noda, 30 Takanawa Minamicho, Shiba, and catalogues should be forwarded to that address. It is stated that portable woodworking machines driven by gasoline engines will be in demand in Japan, but it is impossible at present to use electric motor drive.

COGSDILL MFG. Co., Detroit, Mich., moved on November 1 from 5132 Grand River Ave., to the new plant which it has constructed on Epworth Blvd. The new factory has been provided with modern facilities to afford maximum efficiency in the manufacture of "Cogsdrill," center drills and other products of the company. The factory building is of monitor-type, truss-roof construction, with an abundance of windows to afford ample lighting. A separate building is provided for the offices in front of the factory. The new plant gives the company an increase of 500 per cent in floor space.

MATERIAL HANDLING ADVISORY BUREAU has been organized at 10 S. La Salle St., Chicago, Ill., to provide an advisory and technical consultation service to industrial, storage, and transfer companies on material handling and transport methods, and to promote the more extensive use of mechanical handling equipment of all kinds. The service will range from advice on mechanical details to a complete lay-out of equipment. Harwood Frost, director of the bureau, has had years of experience in the design, manufacture, and application of various types of material handling equipment.

LINK-BELT Co., 910 S. Michigan Ave., Chicago, Ill., has purchased the MEESE & GOTTFRIED Co. of San Francisco, Los Angeles, Seattle, and Portland, manufacturer of power transmission machinery and distributor of conveying and transmission machinery on the Pacific coast. The new organization will be known as the LINK-BELT MEESE & GOTTFRIED Co., and will have its headquarters at 19th and Harrison Sts., San Francisco. The officers are Charles Piez, chairman of the board; B. A. Gayman, president; Harold H. Clark, vice-president and sales manager; Leslie W. Shirley, treasurer; and Richard W. Yerkes, secretary.

HAMILTON PRESS & MACHINERY Co. has been organized for the purpose of manufacturing and selling power presses and special machinery. The executive offices are in Hamilton, Ohio, and the sales and engineering offices are at 516 Marquette Bldg., Detroit, Mich. The officers of the new company are Gordon S. Rentschler, president; C. T. Ziegler, A. A. Byerlein, and R. L. Messimer, vice-presidents; and J. H. Black, secretary and treasurer. Mr. Ziegler is in charge of sales, and Mr. Byerlein is chief engineer. The company is closely affiliated with the Hooven, Owens, Rentschler Co., of Hamilton, Ohio, in whose plants the Hamilton presses will be built.

NORMA Co. OF AMERICA, Long Island City, N. Y., has placed contracts for the erection of the first unit of its new plant at Stamford, Conn. The buildings under construction will be of one-story sawtooth roof type, occupying about 60,000 square feet of space. The new plant will be equipped for the manufacture of Hoffmann precision roller bearings, the American rights to which, as well as to all other Hoffmann products, were recently acquired by the company from the Hoffmann Mfg. Co., Ltd., of Chelmsford, Essex, England. The plant will also be equipped for the manufacture of Norma precision ball bearings. The present plant at Long Island City will be continued for the production of Norma ball bearings.

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France is still maintaining a leading position in the field of aviation. In order to encourage new developments, a great many prizes are being offered by the government, and by cities, aviation clubs, and private concerns for new discoveries. The prizes offered during the first half of 1923 amounted to over 4,250,000 francs. One prize of 175,000 francs is for the attainment of the highest speed. Another prize of 10,000 francs is for the first helicopter which will successfully traverse a closed circuit of one kilometer (about two-thirds of a mile) at an altitude of at least three feet. The take-off and the landing must be effected within a circle of thirty-three feet. This information is transmitted by Vice-Consul Thomas B. Dawson of the United States Consular Service in Paris.

OBITUARIES

HOWARD E. ADT

Howard Ellsworth Adt, president and treasurer of the Geometric Tool Co. of New Haven, Conn., died suddenly on October 14 of heart disease at his home in Woodbridge, near New Haven. Mr. Adt was born in Haydenville, Mass., June 18, 1862, and educated in the public schools of Torrington, Conn. As a youth he studied medicine with the idea of specializing in surgery, but an attractive opening was offered him with the firm of John Adt & Son of New Haven, designing special wire-working machinery, in the manufacture of which that firm specialized. Mr. Adt became very proficient at that work and for fourteen years was the designer and superintendent of construction of John Adt & Son. In 1899 he organized the Geometric Tool Co., which was very successful under his management, and gradually increased from a small to one of the largest concerns in its line, whose product is known and sold all over the world. Mr. Adt returned last September from a three months' trip to Europe, and only recently from a ten days' visit to his camp at Big Island, Maine. Besides Mr. Adt's duties in connection with the Geometric Tool Co., he was a director of two banks, and of Grace Hospital, the Greist Mfg. Co., the English & Mersick Co., and numerous other business companies, clubs and local organizations.

Mr. Adt was a strenuous worker, and gave the best that was in him to whatever he laid his hand to, whether it was in connection with his own business or with public and charitable organizations. He is survived by a widow and one daughter.

ANTOINE J. LANGELIER

Antoine J. Langelier, president, general manager, and treasurer of the Langelier Mfg. Co., Arlington, Cranston, R. I., died suddenly while on a business trip to New York, September 18, at the age of sixty-four. Mr. Langelier was born in the Province of Quebec in 1859. He came with his parents to the United States when a young man, and continued to follow the trade of machinist which he had learned in Canada. The family first settled at Manchester, N. H., but later removed to Providence, where Mr. Langelier was employed for several years with the Brown & Sharpe Mfg. Co. Later, he established, with his father, the Langelier Mfg. Co., located at Clifford & Eddy Sts., Providence. In 1917 the company was incorporated and a new plant was built at Arlington. The Langelier Mfg. Co. has been engaged in the manufacture of special machinery designed by Mr. Langelier, who devoted much time and effort to the development of machinery for hot and cold swaging of metals of different kinds.

EXPERIMENTS ON LUBRICATION

As a result of painstaking researches, made public by Dr. T. E. Stanton, director of the National Physical Laboratory, England, it has been determined that when an ungrooved journal and an ungrooved bearing are run together, although steady running conditions can be obtained, the coefficient of friction is 15 per cent higher than with grooved surfaces in both journal and bearing. It was further found that the substitution of a grooved journal alone for a plain one does not improve the efficiency. Castor oil was used in these experiments. When Bayonne oil was used, the friction with ungrooved surfaces was 22 per cent greater than that produced when grooved surfaces were used. Dr. Stanton, therefore, has come to the definite conclusion that a system of grooving is essential in order to obtain the minimum amount of friction due to the materials of the surfaces and the lubricant employed.

COMING EVENTS

November 19-22—Fall meeting of the Electric Power Club, at French Lick, Ind.; headquarters, French Lick Springs Hotel. Secretary, S. N. Clarkson, Rockefeller Bldg., Cleveland, Ohio.

December 3-6—Annual meeting of the American Society of Mechanical Engineers in New York City. Secretary, Calvin W. Rice, 29 W. 39th St., New York City.

December 3-8—Second annual exposition of power and mechanical engineering in the Grand Central Palace, New York City.

December 5-8—Winter meeting of the American Institute of Chemical Engineers in Washington, D. C. Secretary, J. C. Olsen, Polytechnic Institute, Brooklyn, N. Y.

January 22-25—Annual meeting of the Society of Automotive Engineers in the General Motors Building, Detroit, Mich. Secretary, Coker F. Clarkson, 29 W. 39th St., New York City.

May 19-22—Spring meeting of the American Society of Mechanical Engineers at Cleveland, Ohio. Calvin W. Rice, Secretary, 29 W. 39th St., New York City.

June 4-6 — Eleventh annual foreign trade convention in Boston, Mass. O. K. Davis, India House, Hanover Square, New York City, secretary.

NEW BOOKS AND PAMPHLETS

Tables of Transmission Line Constants. By D. D. Ewing. 32 pages, 6 by 9 inches. Published by Purdue University, Lafayette, Ind., as Bulletin No. 14 of the Engineering Experiment Station.

Electrical House Pumping Systems. By G. C. Blalock and D. D. Ewing. 29 pages, 6 by 9 inches. Published by Purdue University, Lafayette, Ind., as Bulletin No. 4 of the Engineering Extension Service.

Ball Test Applied to Cement Mortar and Concrete. By R. B. Crepps and R. E. Mills. 32 pages, 6 by 9 inches. Published by Purdue University, Lafayette, Ind., as Bulletin No. 12 of the Engineering Experiment Station.

Proceedings of the National Association of Office Managers' Fourth Annual Conference. 121 pages, 8½ by 11 inches. Published by the association; secretary T. G. Woolford, care of the Retail Credit Co., Atlanta, Ga. Price, $2.

Report of the Lathe Tools Research Committee of the Manchester Association of Engineers. 89 pages, 6 by 9 inches. Published by His Majesty's Stationary Office, Imperial House, Kingsway, London, W.C. 2, England. Price, 5 shillings.

This report deals with a long series of investigations to ascertain the best heat-treatment for lathe tools and the best shapes and cutting angles. The report should be of especial value to all users of lathes, and should also be of interest to machine tool manufacturers in general.

Lathe Work. By Paul N. Hasluck. 232 pages, 5 by 7½ inches. Published by the D. Van Nostrand Co., 8 Warren St., New York City. Price, $2, net.

This is the eleventh revised and enlarged edition of a treatise on the tools, appliances, and processes employed in the art of turning, including hand-turning, boring and drilling, the use of slide-rests, screw-cutting by hand, gear-cutting, etc. The book is elementary in nature, having been written essentially as a guide to beginners at the lathe. Much of the material has appeared previously in various technical papers. Chapters have been added on automatic machines and turret lathes.

Blueprint Reading. By Joseph Brahdy. 108 pages, 11 by 8 inches. Published by the D. Van Nostrand Co., 8 Warren St., New York City. Price, $2.50, net.

This book has been prepared as the result of the author's experience in teaching the subject of blueprint reading. The material is carefully graded from the simplest drawings to the more complex, the aim being to enable a student of elementary school training, with little or no knowledge of mechanical drawing, to read the drawings on commercial blueprints. A variety of problems is introduced which are to be solved in various ways—orally, in writing, by drawing or sketching, or by calculations. The book contains ten chapters headed as follows: Blueprint Reading; How an Object is Represented as a Working Drawing; Visible and Invisible Parts of a Working Drawing; the Working Drawing is to Show Measurements; the Scale of a Drawing; Working Drawings of Less or More than Three Views; Orthographic Projections and Blueprint Reading; Conventional Practice; Assembly Drawings and Detail Drawings of a Valve; and Shop Drawings of Brown & Sharpe grinder.

Condensed Catalogues of Mechanical Equipment (1923-1924). 678 pages, 8½ by 11¼ inches. Published by the American Society of Mechanical Engineers, 29 W. 39th St., New York City. Price, $5. (Issued free to members of the society.)

This is the thirteenth edition of this useful directory of catalogue data and mechanical equipment. The present edition shows a gain over the previous issue, having a total of 471 pages of catalogue data carried by 393 firms. There are over 2000 illustrations in the volume. The book is indexed under the products and the firm names, and the alphabetical list of products in each division is repeated on the respective title pages. The mechanical equipment directory contains a classified list, arranged alphabetically, covering the entire field of mechanical equipment. The names and addresses of the manufacturers, as well as the trade names of the products, are included, with reference to the pages in the catalogue section on which these products are shown. The list is carefully cross-indexed. The directory has also increased in comprehensiveness in this edition, containing the names of 4400 firms and 3600 different classifications of equipment. The consulting engineers' directory contains the names of 1000 engineers.

Fundamentals of Welding. By James W. Owens. 672 pages, 6 by 9 inches; 279 illustrations. Published by the Penton Publishing Co., Cleveland, Ohio. Price, $10.

This book constitutes an encyclopedia covering all the branches of welding—gas, arc and thermit. The material is based on the results of research and investigations made by the author in connection with a special study of the subject undertaken for the Bureau of Construction and Repair of the Navy, as well as years of practical experience. The research referred to had for its primary object the determinaton of the relative importance of the various factors affecting the making of welds and their bearing on each other and on the completed structure. The book contains twenty-five chapters headed as follows: Classification and Nomenclature; Preparation and Finish; the Gas Weld; the Arc Weld; Technic of the Arc Weld; the Thermit Weld; Gas and Arc Cutting; Metallography of the Weld; Residual Stresses; Speed and Cost of Welding and Cutting;

Choice of Methods; Design; Inspection and Tests; Production and Distribution of Oxygen, Hydrogen, and Acetylene; Arc Welding Generators and Transformers; Welding and Cutting Machines; Welding Rods, Electrodes, and Fluxes; Protectors and Safety Precautions; Organization, Shop and School Lay-outs; Training; a Practical Gas Welding and Cutting Course; a Practical Arc Welding Course; Standard Specifications; Practical Applications; and Summary and Conclusions.

Thomas' Register of American Manufacturers. 4300 pages, 9 by 12 inches. Published by the Thomas Publishing Co., 461 Eighth Ave., New York City. Price, $15.

The fourteenth edition of this well-known purchasing guide and directory has been thoroughly revised and brought up to date. The present edition contains 100 more pages than the previous one, and incorporates more than 200,000 changes. The arrangement is the same as in previous years. The first section of the book, printed on yellow paper, contains the index or finding list; the second and main section of the book, printed on white paper, contains a classified list of the products of all the manufacturing industries in the United States, including the names and addresses of the manufacturers (together with their capital or size ratings), grouped under cities or towns in alphabetical order; the third section of the book, printed on blue paper, comprises an alphabetical list of manufacturers, giving the names, addresses, branches, etc. The last section of the book, printed on pink paper, gives an alphabetical list of the trade names of all the products represented in the classified section, together with the names and addresses of the manufacturers. With this arrangement it is possible for buyers or sellers to locate readily any product or class of manufacturers. The information is complete in each section, so that it is seldom necessary to look in more than one place, and the book is thoroughly cross-indexed to facilitate reference. The appendix contains a list of the representative banks in the United States, commercial organizations, and leading trade journals.

Kent's Mechanical Engineers' Handbook. By the late William Kent. Tenth Edition, rewritten by Robert Thurston Kent and a staff of specialists. 2247 pages, $4\frac{1}{4}$ by 7 inches. Published by John Wiley & Sons, Inc., 432 Fourth Ave., New York City. Price, genuine leather binding, $7; Atholeather, $6.

This new and revised edition of Kent's well-known mechanical engineers' handbook has been considerably enlarged, both in the form and the scope of the information contained. The book has been completely rearranged, and several subjects are now grouped in a more convenient manner than in earlier editions. Many new subjects appear in the work, among them aeronautics, automobiles, reinforced concrete, and safety engineering. Entire sections of the handbook have been prepared by specialists in the field. In the arrangement of the book, care has been taken to place on the same page, or on facing pages, the reference and the table, formula, or illustration to which it refers. In presenting formulas, the notation used in the formula is given immediately below the formula instead of at the head of the section—a very commendable feature. The subjects covered by this new edition of Kent's handbook deal with mathematics, strength and other characteristics of materials, iron and steel, non-ferrous metals and alloys, mechanics, heat, air, hydraulics, pumps, fuels, steam power, gas power, power transmission, transportation, hoisting and conveying, machine design, friction and lubrication, shop practice, refrigeration, buildings, heating, ventilation, illumination, marine engineering, electrical engineering, and safety engineering. The section on transportation is subdivided into railway engineering, automotive vehicles, and aeronautics.

NEW CATALOGUES AND CIRCULARS

Lewis-Shepard Co., 568 E. First St., Boston, Mass. Circular illustrating the use of "Jack-lift" elevating trucks and stackers.

U. S. Gutta Percha Paint Co., Dudley St., Providence, R. I. Circular advertising a white paint known as "Barreled Sunlight," for factory and other uses.

Herberts Machinery & Supply Co., 401 E. 3rd St., Los Angeles, Cal. Catalogue and price list of the machine tools and woodworking machinery carried in stock by this company.

Hy-way Service Co., South Bend, Ind. Circular descriptive of the Williams vertical cylinder grinder, which is adapted for use both in manufacturing plants and motor service stations.

Sundh Mfg. Corporation, 342 Madison Ave., New York City. Circular outlining the principal features of the Sundh flexible and shock absorbing couplings, which are designed to compensate for misalignments of shafting.

Oliver Instrument Co., Adrian, Mich. Circular entitled "Increase Drilling Production," illustrating and describing the Oliver automatic drill pointer, a machine employing a new grinding principle for twist drill sharpening.

Consolidated Tool Works, Inc., 296 Broadway, New York City. Catalogue E, covering the line of tools made by this company, and a new quotation sheet No. 29, effective October 1. Copies will be sent to anyone interested, upon request.

Whiting Corporation, Harvey, Ill. Catalogues 169 and 170, illustrating and describing, respectively, air hoists and elevators, and core oven equipment. Six-page folder illustrating the use of Whiting screw jack locomotive hoist in railway shops.

Tomkins-Johnson Co., Jackson, Mich. Circular descriptive of the Higgins new and improved flexible couplings, which are so designed as to compensate for axial and angular misalignment of shafts and which allow for a slight end motion of the shafts.

Ingersoll Milling Machine Co., Rockford, Ill. Folder illustrating the adaptability of Ingersoll adjustable-rail milling machines to general shop conditions. The representative jobs shown give a good idea of the class of work for which these machines are adapted.

Tomkins-Johnson Co., Jackson, Mich. Circular illustrating and describing Higgins flexible couplings, which are claimed to eliminate axial and angular misalignment of the shafts, provide freedom of one or both shafts to move endwise, and insure proper lubrication.

Tabulating Machine Co., 50 Broad St., New York City. Circular descriptive of the ticketograph method of production control, which has as its basis a production indicator that registers graphically the progress of an order by means of coupons printed on the ticketograph.

Smith & Serrell, 46 Central Ave., Newark, N. J., are distributing reprints of an article entitled "Flexible Couplings for Steel Mills and Other Drives," by John J. Serrell, presented before the Pittsburg Section meeting of the Association of Iron and Steel Electrical Engineers.

Grindle Fuel Equipment Co., Harvey, Ill. Bulletin 6, entitled "What Pulverized Coal is doing for Malleable Foundries." The bulletin contains a table of comparative costs of hand firing, oil firing, and pulverized coal firing, and demonstrates the advantages of pulverized coal as a fuel in foundries.

Hisey-Wolf Machine Co., Cincinnati, Ohio. Bulletin 1305, illustrating and describing Hisey ball-bearing grinding machines, which are made in six sizes ranging from $\frac{1}{2}$ to 10 horsepower capacity. The circular contains a general description of this line of machines and tables of specifications covering the different sizes.

Acme Electric Welder Co., 5615 Pacific Blvd., Los Angeles, Cal. Circular containing specifications covering the types B and D electric spot welders made by this concern. The circular also contains a detailed description of these machines and a table showing the time and power required and the cost of spot-welding sheet steel and iron.

General Motors Corporation, Detroit, Mich. Loose-leaf catalogue and binder, containing specifications for ferrous and non-ferrous metals, steel (including typical heat-treatments), lubricants, and petroleum products, solvents, leather and leather products, chemicals, carburizing compounds, and building and factory maintenance supplies.

Bristol Co., Waterbury, Conn. Bulletin 317, containing information on Bristol recording and indicating tachometers for determining the speed of engines, shafting, and individual machines. Two types of tachometer equipment are described in the bulletin—the pneumatic and the electric—and the special functions of each are pointed out.

Reliance Electric & Engineering Co., 1056 Ivanhoe Road, Cleveland, Ohio. Bulletin 2014, illustrating and describing Reliance type T heavy-duty motors for direct current. The bulletin includes tables of ratings and dimensions for the various sizes. A large number of illustrations show the application of this motor to different classes of work.

Kinite Co., Milwaukee, Wis. Booklet descriptive of "Kinite," a cast alloy of steel for use in making drawing, blanking, and forming dies. A large number of these dies are illustrated. Dies are also shown made of "Kompite," which is a combination casting with "Kinite" as the working face on a mild steel base. For large dies this is lower in cost than "Kinite."

Torchweld Equipment Co., 224 N. Carpenter St., Chicago, Ill. Catalogue 23 (40 pages, $8\frac{1}{2}$ by 11 inches) covering the complete line of products made by this company, including oxy-acetylene welding and cutting apparatus, lead welding, soldering, brazing and decarbonizing units, gas-pressure regulators, automatic machines, generators, and supplies. Copies will be sent upon request.

James H. Matthews & Co., 3946 Forbes Field, Pittsburg, Pa. Circular descriptive of Matthews "Champion" holders for steel stamp numbering and lettering. These holders are made in different styles for light marking, hot marking, convex marking, double-line marking, heavy marking, curved-line marking, inspection marking, and for interchangeable numbering where a press is available.

Parker-Kalon Corporation, 352 W. 13th St., New York City. Circular descriptive of the Parker-Kalon hardened metallic drive screws, which cut their own thread in steel, cast iron, bakelite, etc., and thus eliminate tapping. These screws are convenient for attaching name and number plates to tools, machines, pumps, etc., and for assembling small parts where a permanent fastening is desired.

Hanna Engineering Works, 1763 Elston Ave., Chicago, Ill. Circular illustrating and describing Hanna hydraulic riveters which are built in two types having triple-power cylinders and six-power cylinders, respectively. The triple-power cylinder riveter is made in seven sizes ranging in capacity from 50 to 150 tons, and the six-power cylinder is made in seven sizes ranging in capacity from 60 to 150 tons.

Mitchell-Rand Mfg. Co., 18 Vesey St., New York City. Catalogue 423, entitled "Everything in Insulation," containing data on various classes of insulation, including asbestos, fiber, mica, paint, papers, rubber, varnishes, etc. Considerable general information on these products is included. Circular entitled "Pertinent Paragraphs," containing excerpts from the book entitled "Everything in Insulation."

Reliance Electric & Engineering Co., 1056 Ivanhoe Road, Cleveland, Ohio. Pamphlet entitled "Anti-friction Bearings in the Steel Mill," containing a paper by A. M. MacCutcheon, chief engineer of the company, which was presented before the Association of Iron and Steel Electrical Engineers. The paper is written from such a standpoint that it is of general interest and value to users and designers of machinery and power equipment in other industries besides the one referred to.

Bethlehem Steel Co., Inc., Bethlehem, Pa. Handbook 26, describing the nature and uses of Mayari pig iron—a natural nickel-chromium alloy iron for making high-grade castings. The book has been greatly enlarged and extended, as compared with its original form, and contains some data compiled especially for this book by Dr. Richard Moldenke, an international authority on foundry work. The book is in the nature of a treatise on this subject, and should be of especial interest to foundrymen.

Andrew C. Campbell, Inc., Bridgeport, Conn. Circulars giving specifications for different sizes of the Campbell patent nibbling machine for the rapid cutting of sheet metals and composition sheets. This machine has been designed to meet the need for a device for accurately and rapidly cutting sheet stock to required outlines, when the quantity required is not sufficient to justify the making of press blanking tools. Circular containing instructions for the care and operation of Campbell nibbling machines.

Morse Chain Co., Ithaca, N. Y., is issuing a pamphlet containing an article on the history of the application of power from the seventeenth dynasty to the twentieth century. This booklet is of unusual interest from the historic point of view. The illustrations, reproduced from copies of hieroglyphics and ancient paintings, show the devices for utilizing power employed by the Egyptians, Romans, and other early peoples. The story proceeds from the earliest developments, through the middle ages, up to the present-day accomplishments in the transmission of power.

Doehler Die-Casting Co., Brooklyn, N. Y. Booklet containing a brief review of the die-casting process, as well as a description of the evolution of "Do-Di" brass castings, and miscellaneous engineering and metallurgical data relating to the die-casting process. The book is more of the nature of a text-book than a mere catalogue of products. The information presented covers the design of dies, design of die-cast parts, cost of dies, life of dies, etc., and it should, therefore, be of assistance to those having to do with the use of die-cast parts. The last part of the book contains illustrations of a large number of die-cast parts which give a good idea of the scope of the process.

Polytechnic Institute of Brooklyn, 99 Livingston St., Brooklyn, N. Y. Circular descriptive of the courses in automotive engineering offered by the institute. These courses are open to both day and evening students, and cover a two-year period, extending from October, 1923, to February, 1924, and from February to June. The four parts of the courses are as follows: Preliminary study of the principal types of engines and their various applications; laboratory testing; chassis; and electrical equipment. Further information may be obtained from the registrar concerning the day courses, and from the director of the evening department concerning the evening courses.

Chain Belt Co., Milwaukee, Wis. Catalogue 210, containing 512 pages, $7\frac{1}{4}$ by $10\frac{1}{4}$ inches (cloth bound), covering the complete line of "Rex" chains and conveyors. This comprehensive book gives prices, weights, and information on the design and application of chain and machinery for power transmission, material conveying, material and water screening, and concrete mixing. It also illustrates the wide range of "Rex" castings in malleable iron, gray iron, semi-steel, and electric steel, as well as drop-forgings. The purpose of the book is to serve, first, as a catalogue, and second, as a technical data book enabling engineers and users to select intelligently the equipment best suited to their needs. The products covered include chain drives and conveyors, detachable chain, sprocket wheels, belting, pulleys, gearing, shafting and keys, couplings, clutches, bearings, shaft hangers, transmission supports, belt conveyors, screw conveyors, traveling screens, etc.